Vision Series:
Power Management

Optimize Your Power Design With Building Blocks from NXP

Topics to be covered

- *Market overview*
- *AC/DC Design*
- *DC/DC Design*
- *Switching Devices*
- *Summary*

Market Overview

Application Guide

AC/DC Conversion

- GreenChip
  - High eff at wide load range
  - Designs up to 500W
- Discretes
  - BISS
  - MEGA Shottky
- Power Diodes
  - NUR460P, BYC30X
  - 600V ultra low leakage
  - Reduces switching losses in MOSFET or IGBT

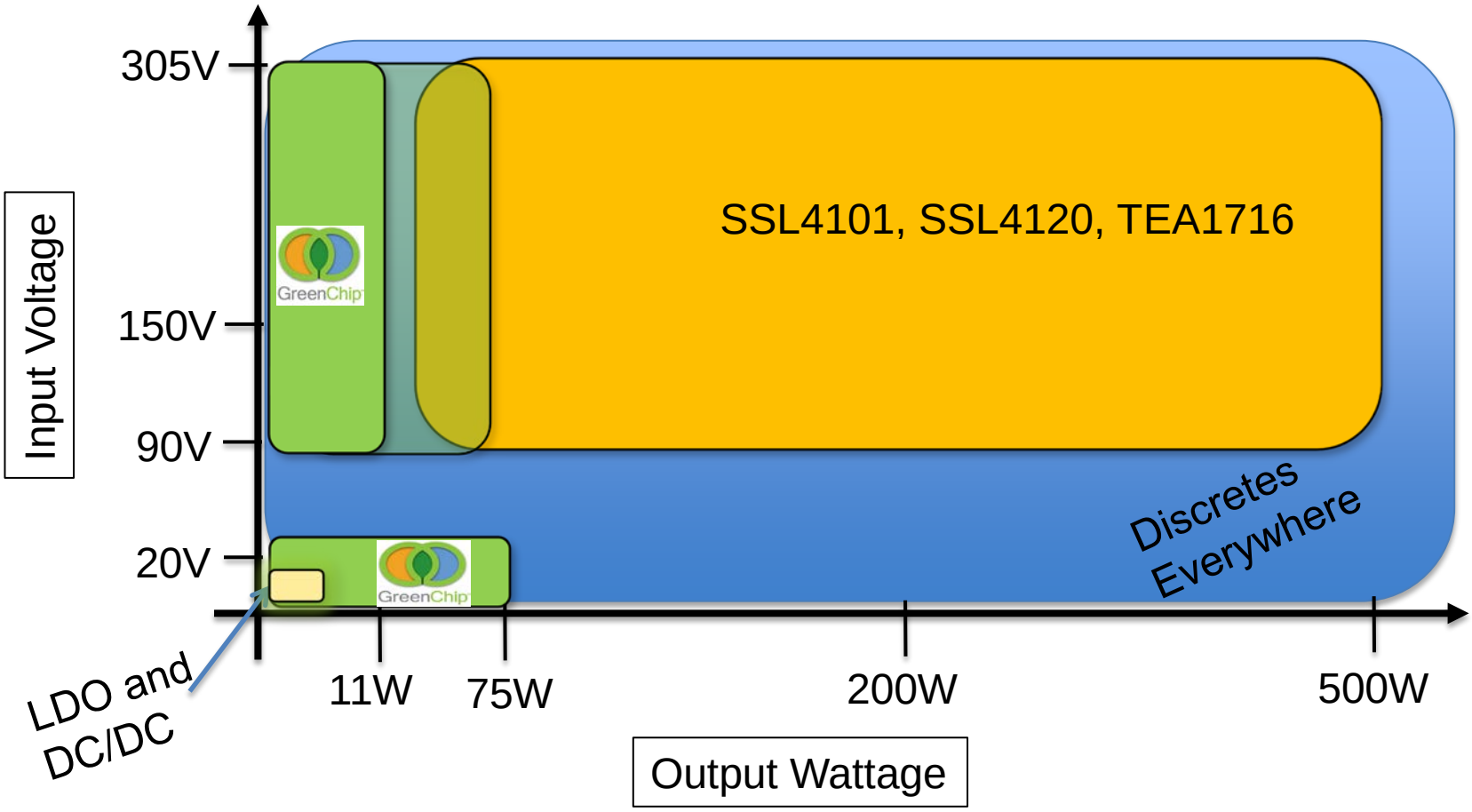
DC/DC Conversion

- LDO
  - LD68x***y***
  - Low in rush and soft start
- DC/DC
  - DCMx
  - High eff at wide load range
- GreenChip
- Discretes
  - BISS
  - MEGA Shottky
- Power MOS
  - PSMNx, BUFKx
  - Lowest RDSon / High Switching
  - LFPAK56, LFPAK33
  - Best in class current and avalanche

Switches and External Devices

- PFC
  - BYCx, BYVx, BYRx, BYWx
  - Optimized for PFC
- MOSFETs
- Load switches
- ORing MOSFETs

Power Range Selection Guide



Application Guide

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General Survey SMPS ICs

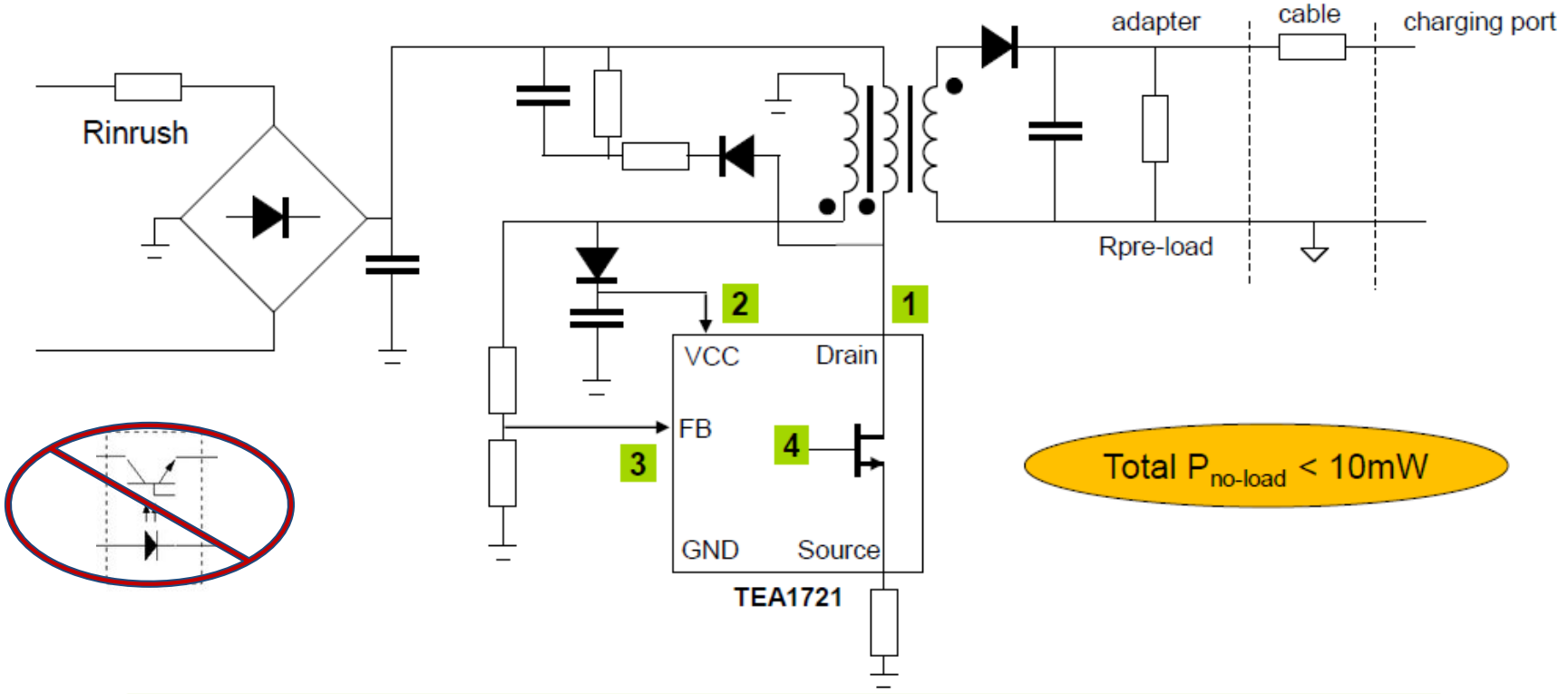
GreenChip

<table>
<tr><th>typ. applications</th><th>PFC control</th><th>primary control</th><th>secondary control</th><th>STBY control</th></tr>
<tr><td>Resonant
typ. >90W</td><td colspan="2">TEA171x (TEA1716)
(Greenchip Resonant)</td><td>TEA1791A
TEA1795
(Greenchip SR)</td><td>Parallel supply
TEA173x
(GreenChip LowPower)</td></tr>
<tr><td>Flyback >75W</td><td colspan="2">TEA175x(TEA1750/51/52/TEA1753/55)
(Greenchip III)</td><td rowspan="2">TEA176x
(TEA1761/62)
TEA179x
(TEA1792)
(Greenchip SR)</td><td rowspan="2">TEA1703
(Greenchip Standby)</td></tr>
<tr><td>Flyback
<75W</td><td>n.a.</td><td>TEA153x (TEA1530/TEA1532/33)
TEA155x (TEA1552)
(QR FLB diff. f_{osc})
(Greenchip II)
TEA173x (TEA1731/33/38)
(Greenchip III; LP)</td></tr>
<tr><td>Flyback
<15W</td><td>n.a.</td><td>TEA172x (TEA1721/3)
(Greenchip SP)</td><td>n.a.</td><td>Integrated in Primary IC</td></tr>
</table>

TEA1721/TEA1723 Special Features

8

ii) Achieving low no-load power



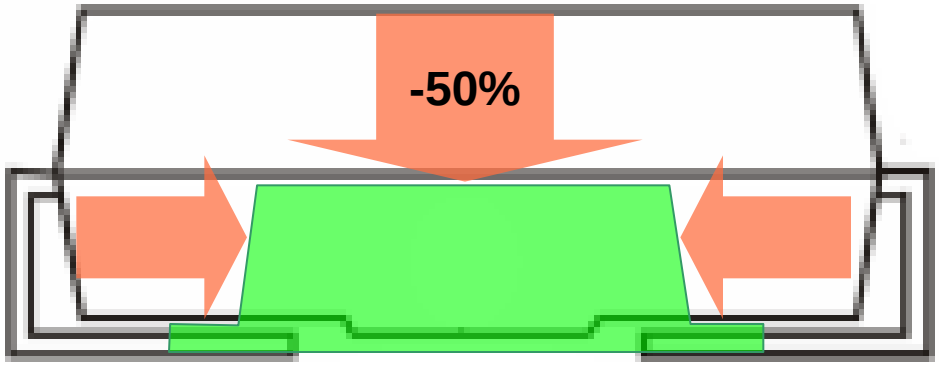
Features for low no-load input power

1. Integrated start-up current source with disable function in switching operation: no dissipative bleeder current
2. Very low IC consumption in no-load: 100uA supply current
3. Primary sensing via transformer: no current consuming opto-coupler and secondary shunt regulator
4. Low switching frequency in no-load for low switching losses and sufficient load step response

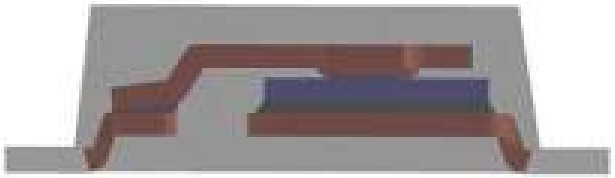
FlatPower Diodes

- What if...
  ...you could get simply small devices with full performance

Too big?



- Clip-Bond technology enabling full performance with small form factor



SOD123W

SOD128

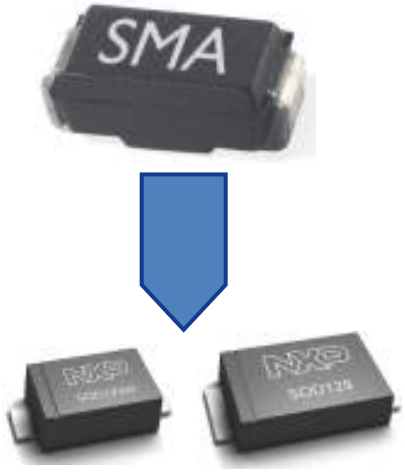
MEGA Schottky rectifiers

10 Key features

Significantly increased performance

- Broad portfolio optimised for either
  - Extremely low V_F
  - Very low V_F and low I_R
- Lower power dissipation due to low V_F
- High temperature applications due to low I_R
- Higher efficiency, lower temperature rise, higher ambient temperatures
  Reduced energy consumption, longer battery operating time

$$P_{tot} = V_F \times I_F + V_R \times I_R$$



➔ offer maximum performance in small packages up to **5 A**
➔ created a broad portfolio with our new FlatPower packages
➔ technology also used in SOT23 package: PMEGxx10ET, 1A-series

MEGA Schottky rectifier

portfolio single ultra low V_F PMEG Schottky diodes

I_F max. (A)	V_R max. (V)	Package	SOD128	SOD123W	SOD123F	DFN2020-3 (SOT1061)	SOD323 (SC-76)	SOD323F (SC-90)	SOT23	SOT666	DFN1608D-2 (SOD1608)	SOD523 (SC-79)	DFN1006-2 (SOD882)	DFN1006D-2 (SOD882D)
														
		Size (mm)	3.8 x 2.5 x 1.0	2.6 x 1.7 x 1.0	2.6 x 1.6 x 1.1	2.0 x 2.0 x 0.6	1.7 x 1.25 x 0.95	1.7 x 1.25 x 0.7	2.9 x 1.3 x 1.0	1.6 x 1.2 x 0.55	1.6 x 0.8 x 0.37	1.2 x 0.8 x 0.6	1.0 x 0.6 x 0.5	1.0 x 0.6 x 0.4
		P_{tot} (mW)	1050	950	830	960	600	700	420	300	795	500	310	340
0.2	30							x				x	x	x
	40							x				x	x	x
	60							x				x		
0.5	20				x		x	x	x	x	x	x	x	x
	30				x		x	x	x	x		x	x	x
	40				x		x	x	x	x	x			
1.0	20			x	x	x	x	x	x	x	x	x		x
	30		x	x	x		x	x	x	x		x		
	40		x	x	x		x	x	x	x	x			
	60		x	x	x		x	x						
1.5	20				x		x	x		x	x			
	30				x			x		x				
	40										x			
2.0	10				x		x	x		x				
	20				x	x	x	x			x			
	30		x	x	x	x		x						
	40		x	x		x					x			
	60		x	x		x								
3,0	10				x			x						
	30		x											
	40		x	x										
	60		x											
5,0	30		x											
	40		x											

FlatPower portfolio

New leadless portfolio

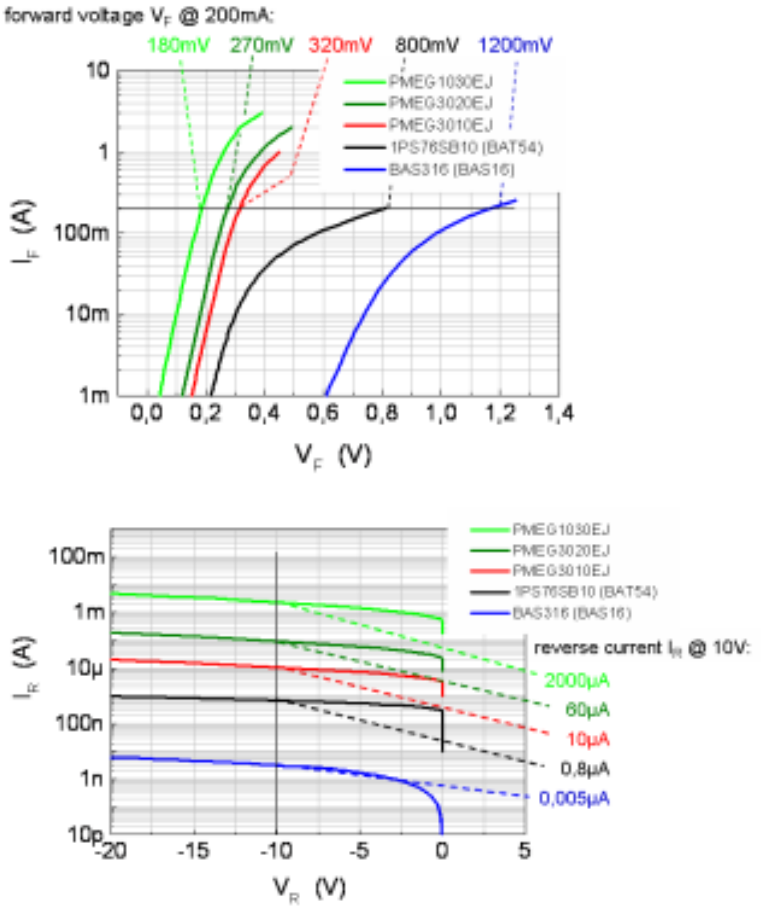
New solderable side pads

New solderable side pads

MEGA Schottky rectifiers

12 *Characteristics and Technology*

Low V_F and low I_R



MEGA technology

- Chip design: maximisation of Si-content/package and active area/pitch

- Process Technology: 4 different Schottky metallizations available, low ohmic base material

Chip cross section:

metallization layer: Ti, Ti:Si, WTi, NiFe
Si-epitaxial layer
Si-substrate

- Packages: optimized thermal performance design and materials

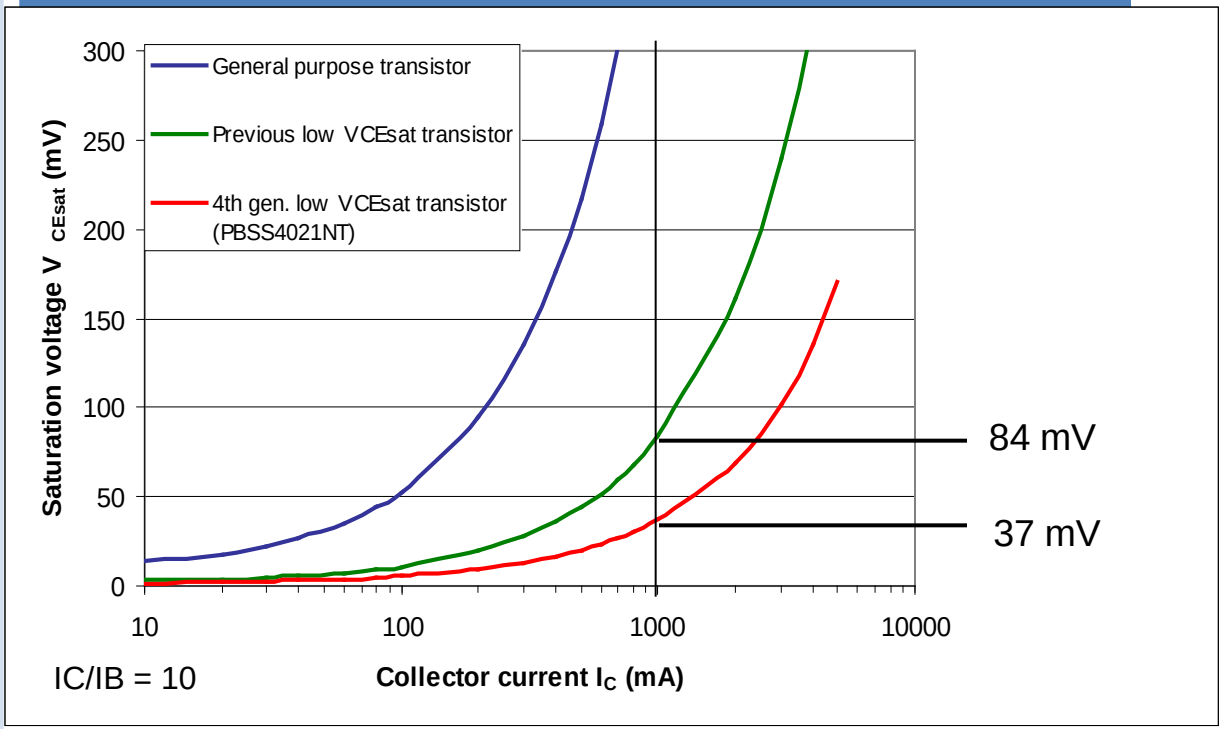
➔Schottky technology – balancing low VF and low IR requirements

BISS Transistors – advantages of low power dissipation

Key advantages

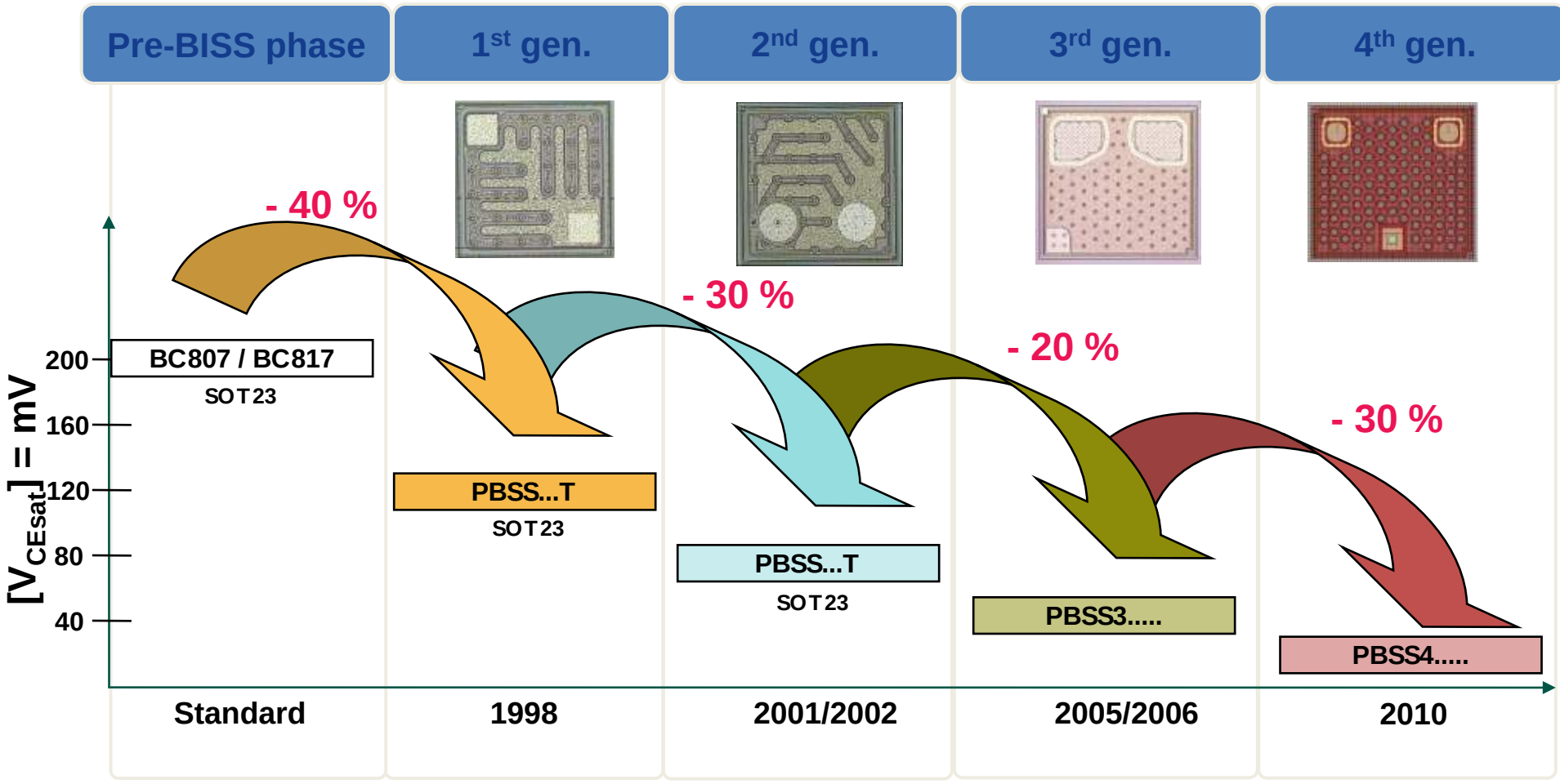
- Up to 8 times better efficiency
- Lower temperature rise
- Higher reliability
- Reduced energy consumption
- Longer battery operating time

$$P_{tot} = V_{BEsat} \times I_B + V_{CEsat} \times I_C$$



BISS performance evolution

Continuous improvement to reduce V_{CEsat}



Reduction in board space

15 ## An example

Stable performance at smaller footprint

I_C = 0.5 A, V_{CEO} = 40 – 45 V

SOT23
8.15 mm²

Standard technology

BC817

SOT323 (SC-70)
5.37 mm²

Standard technology

BC817W

SOT416 (SC-75)
4.4 mm²

Standard technology

Not applicable

BISS technology

PBSS2540E

SOT883 (SC-101)
1.17 mm²

Standard technology

Not applicable

BISS technology

PBSS2540M

Improved performance

16 An example

Increased performance on stable footprint

17.87 mm² footprint

SOT89 (SC-62)
17.87 mm²

1 A

Standard technology

BCX51

SOT89 (SC-62)
17.87 mm²

3 A

Standard technology

Not applicable

BISS technology

PBSS5350X

SOT89 (SC-62)
17.87 mm²

4 A

Standard technology

Not applicable

BISS technology

PBSS5540X

SOT89 (SC-62)
17.87 mm²

5.1 A

Standard technology

Not applicable

BISS technology

PBSS301PX

Low V_{CEsat} (BISS) transistors

17 *Product news: High-Voltage BISS*

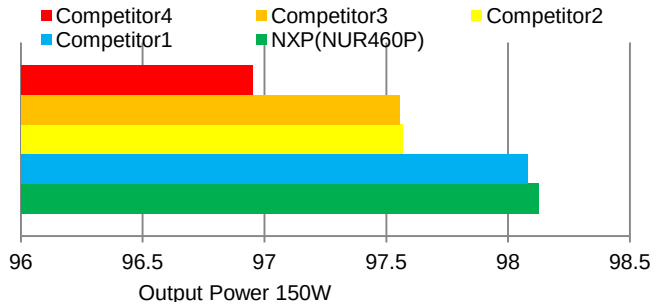
- Typical current gain h_{FE} of 200
- V_{CEsat} of typical 225 mV at Ic = 1 A

HV + BISS: boost in high-voltage performance
miniaturisation of HV functionalities to smaller footprints

Power diode: NUR460P (4A, 600V) *new release*

Key Applications

Benchmark test (adapter)



Product overview

- Voltage: 600V
- Current: 4A
- Technology : Platinum doped ultrafast diodes
- Packages: SOD141(DO201-AD) axial leaded plastic

Comprehensive lead forming

Key features and benefits

- Low V_F and fast switching (V_F = 0.88V@ I_F = 4A,150°C)
- Soft recovery minimises oscillation
- Ultra low leakage current
- Low thermal resistance
- Comprehensive lead forming offerings
- Tj = 175°C

Product Specification

Download datasheet

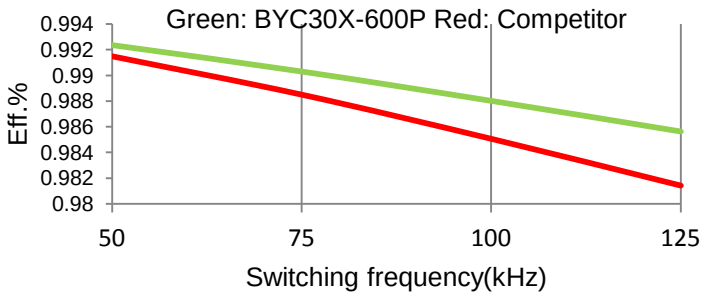
NXP Power diodes: BYC30X-600P *new release*

19

Product overview

- Voltage: 600V
- Current: 30A
- Package: TO-220FP
- Pb &Halogen free
- BYC hyper fast type for CCM mode PFC

Benchmark (efficiency)



Key features and benefits

- Low V_F and fast switching
- Reduces switching losses in associated MOSFET or IGBT
- Ultra low leakage current by platinum doped technology
- T_j = 175°C

Product Specification

PDF Product Specification

Download datasheet

Key applications

- Inverter based room air conditioners
- S.M.P.S. for server
- Freewheeling diodes for industrial machine

Cross reference

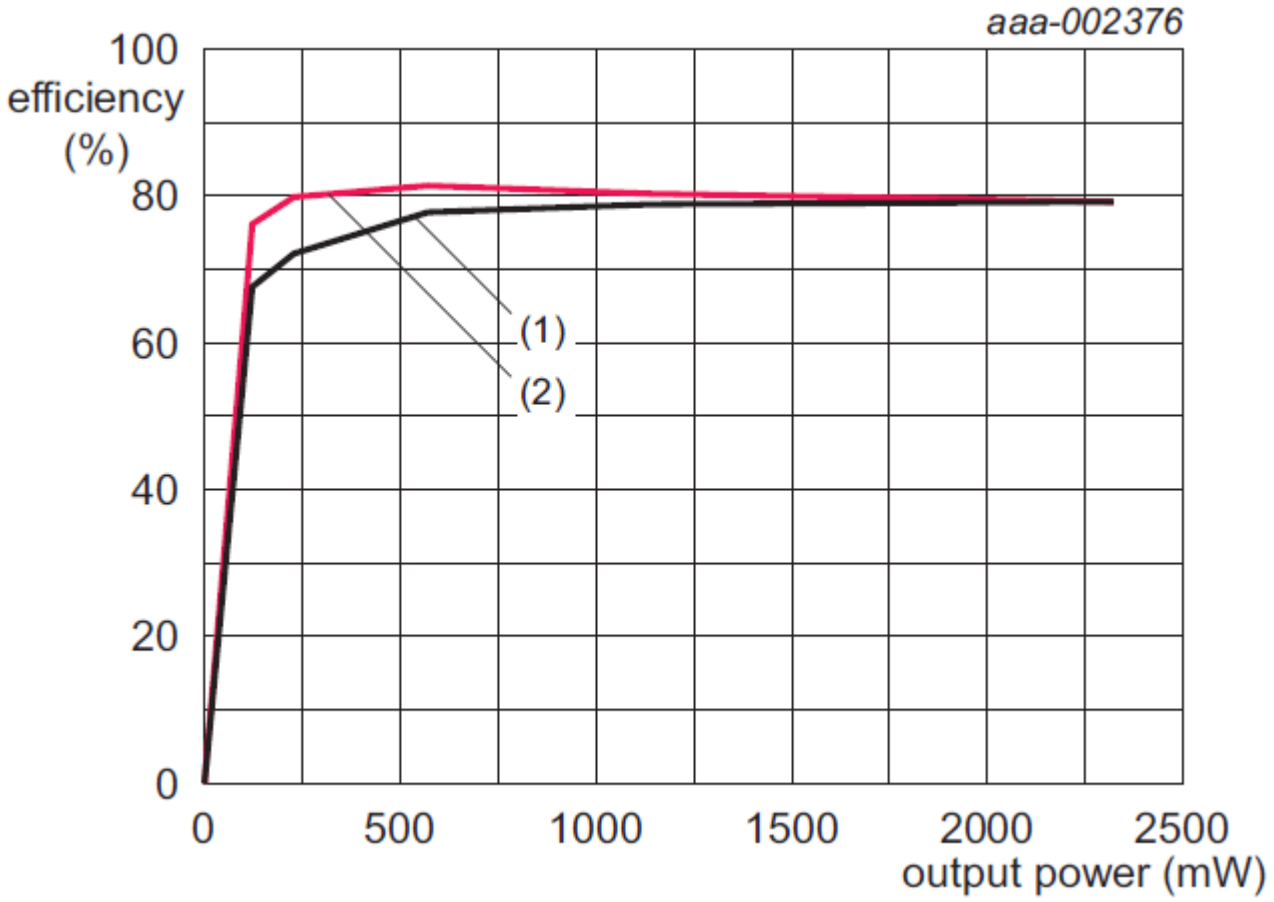
Vishay: ETH3006FP

Efficiency, Efficiency, Efficiency

- One of the key parameters to look at
- Results of poor efficiency
  - Generate more heat
  - Larger switching devices
  - May not meet regulatory conditions
  - Rebates from municipalities on certain designs
- Look at operating conditions
  - Input voltage range is critical
  - Efficiency over load conditions

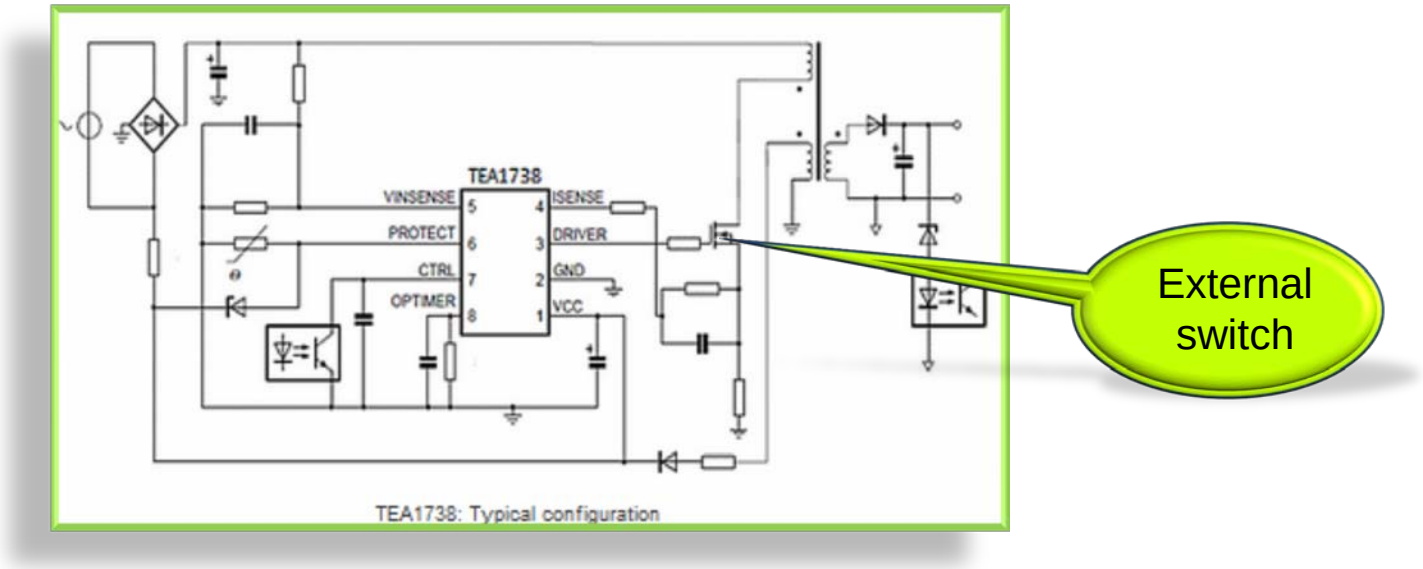
Efficiency

- Buck mode: Typical Efficiency



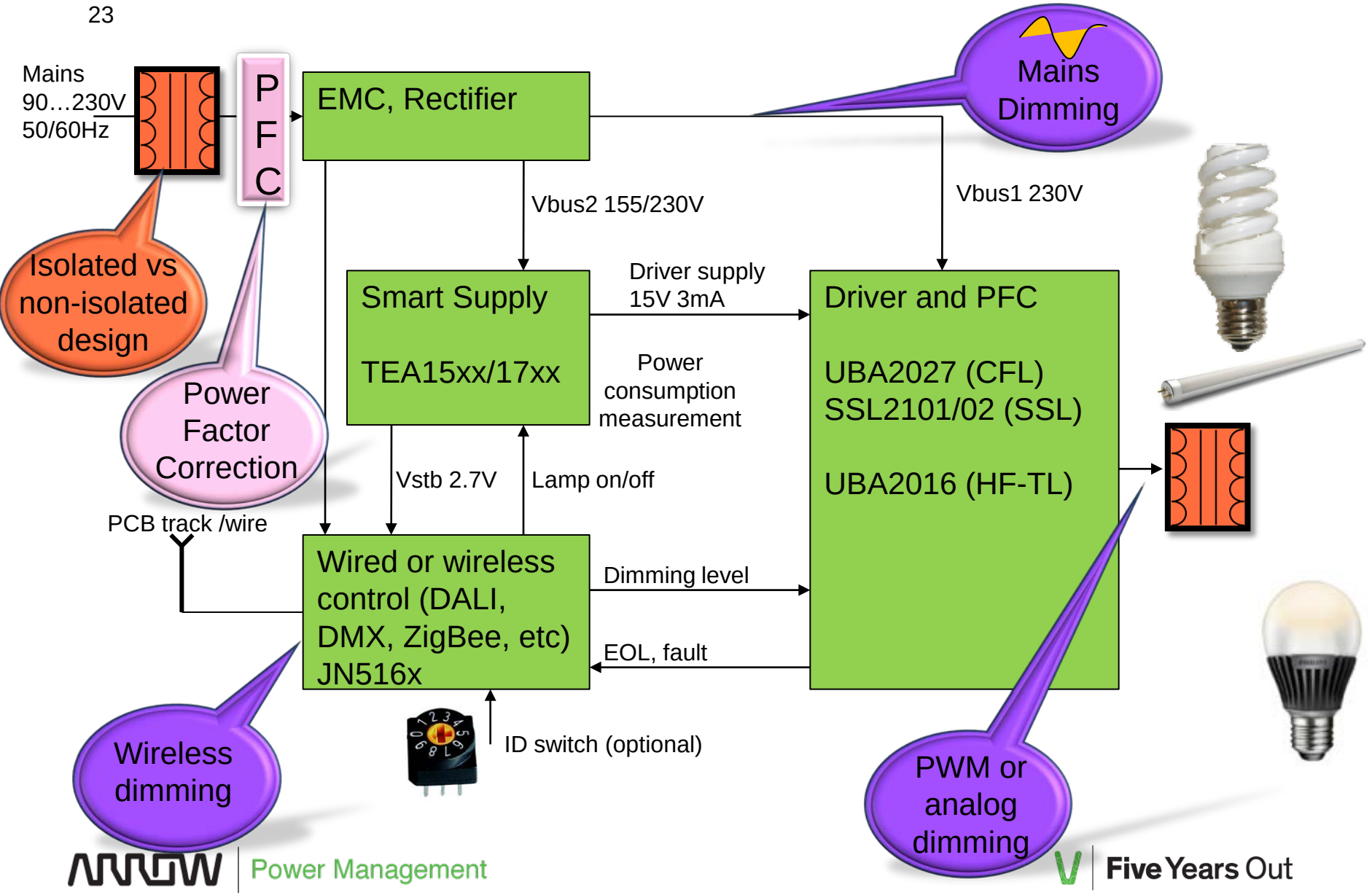
(1) 230VAC
(2) 115VAC

Why the Power Limitation on GreenChip



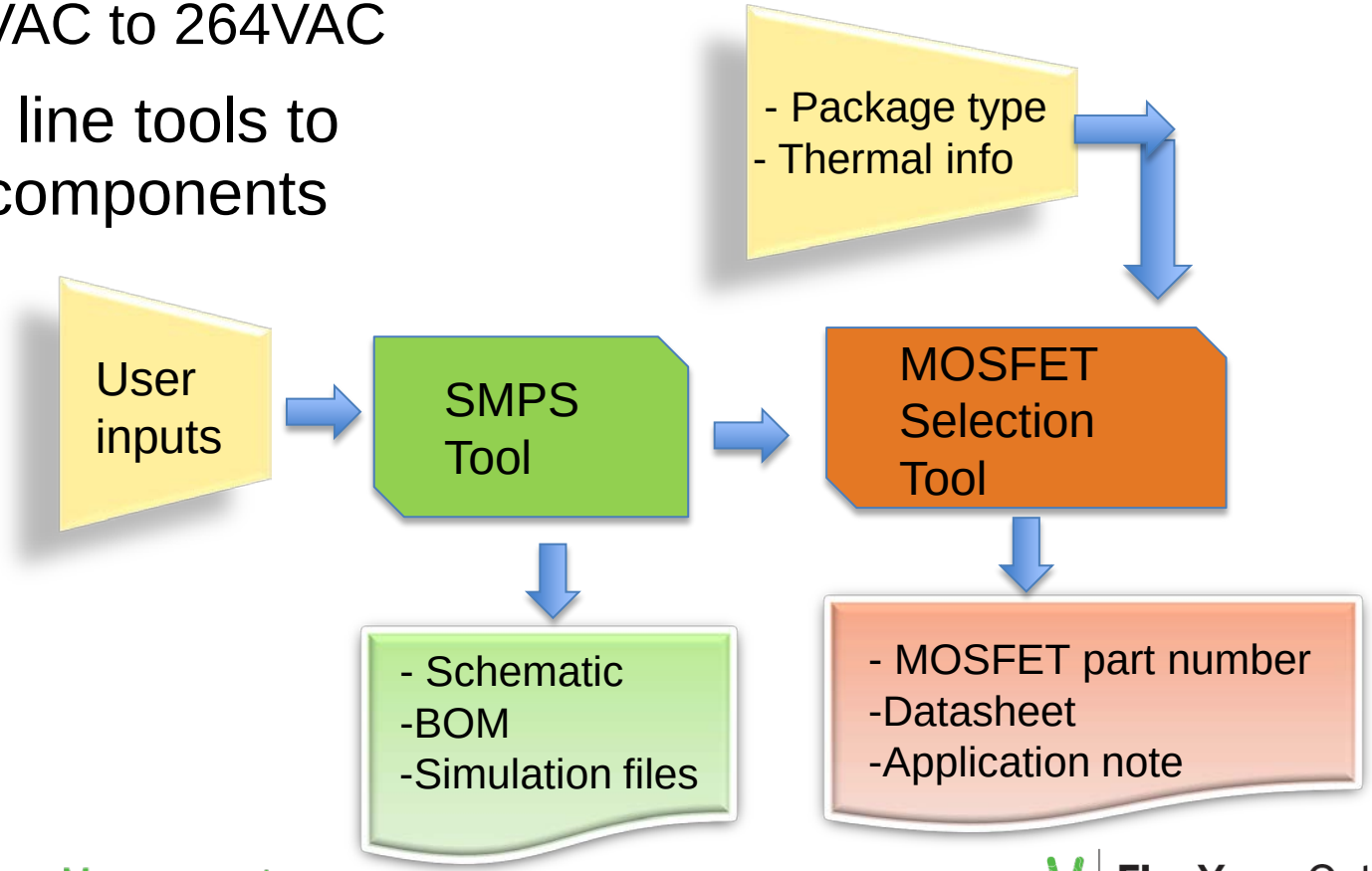
- *Has external switch so it is capable of much higher wattages*
- *Regulatory requirements*
- *Efficiency, Power Factor, etc*

AC/DC Example - Lighting Platform



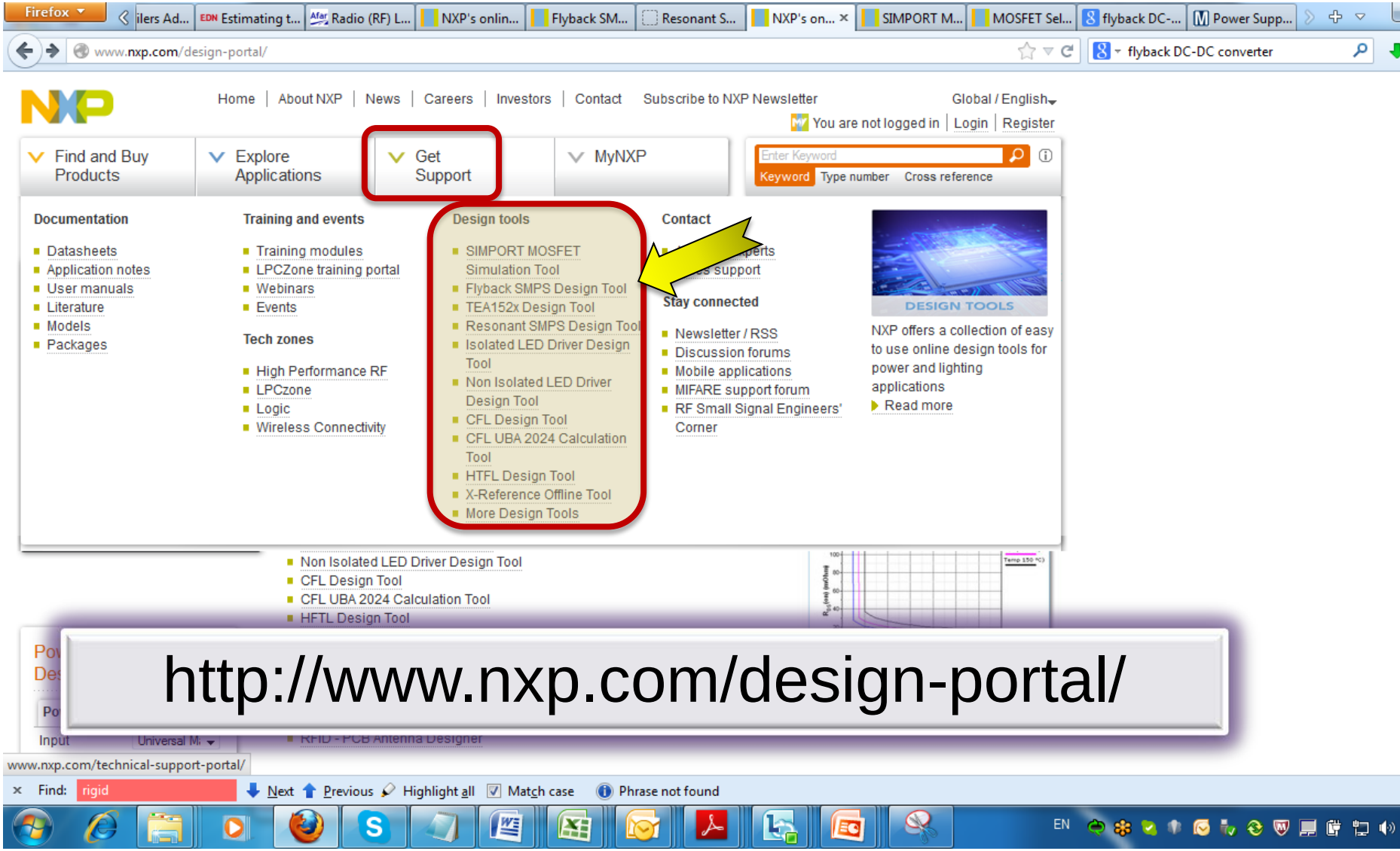
AC/DC - Design Example #2

- Design parameters
  - Use TEA1733
  - Vout = 24V
  - Vin = 90VAC to 264VAC
- Use the on line tools to select the components



Design Tools

- From the main NXP menu or direct link



Flyback SMPS Design Tool

Flyback converter

Hello: Guest | Login
Language: English

Basics
- Input specifications
- Key requirements
- IC selection

Design
- Bulk capacitor
- Winding ratio
- Inductance
- Transformer

Design
- Output cap
- Controls
- Protection

Options
- Waveform

Key Results
- Schematic
- Part list

Summary
- Show
- Print
- PDF
- Excel

More
- Datasheet
- Product info
- Ask a question
- Give feedback

My Designs
- New
- Save
- Load
- Share

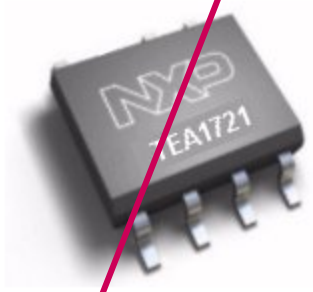
Input Specifications

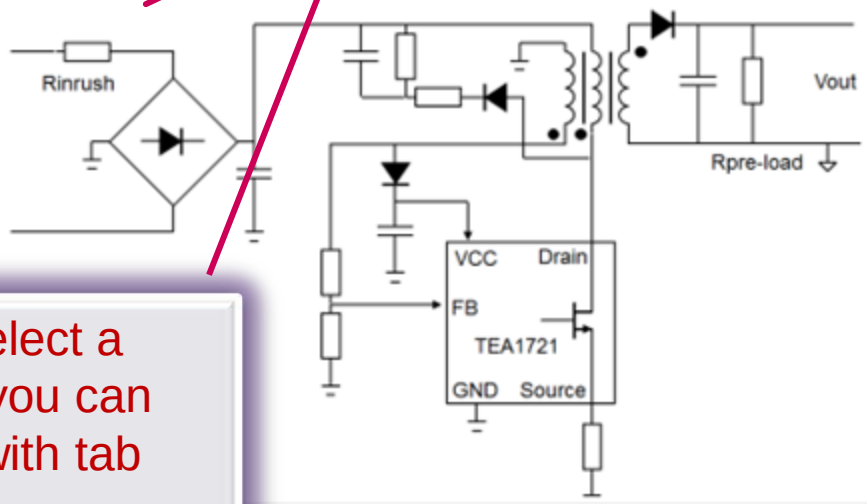
AC input
- (•) Universal mains (90VAC to 264VAC)
- ( ) User defined

Voltage
- Minimum: 90 VAC
- Maximum: 264 VAC

Frequency
- Typical: 50 Hz

TEA1721 | TEA1723 | TEA1731 | TEA1733 | TEA1738





Enter values and schematic is shown

Tool will select a device or you can over ride with tab selection

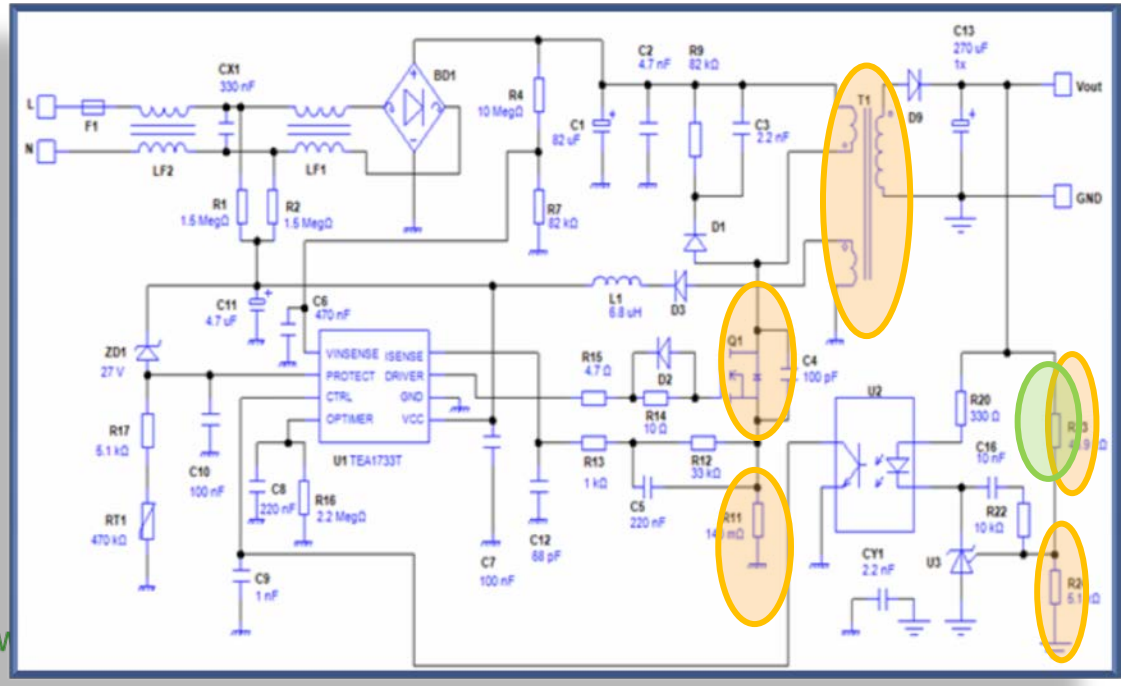
Quick help

Select AC input voltage range and frequency

More...

Design Output

- Provides schematic that is very similar to the development board
- Approach #1: Modify dev board with recommended BOM
  - Replace discrete devices
  - Replace transformer
  - Replace passive components
- Approach #2: Use dev board and just modify output voltage
  - Gives a close approximation



Design Output

- Approach #2: Use dev board and just modify output voltage
  - Gives a close approximation
  - For the TEA1733
    - User Manual UM10385
    - Section 8.1, changing output voltage
    - Vo = 2.5V + (R23+R24)/R24
  - Keep R24 the same as demo board (5.23 Kohm)
    - Solve for R23
    - R23 = (Vo) (R24) / 2.5V – R24
    - R23 = (V0) (5.23Kohm) / 2.5V – (5.23Kohm)

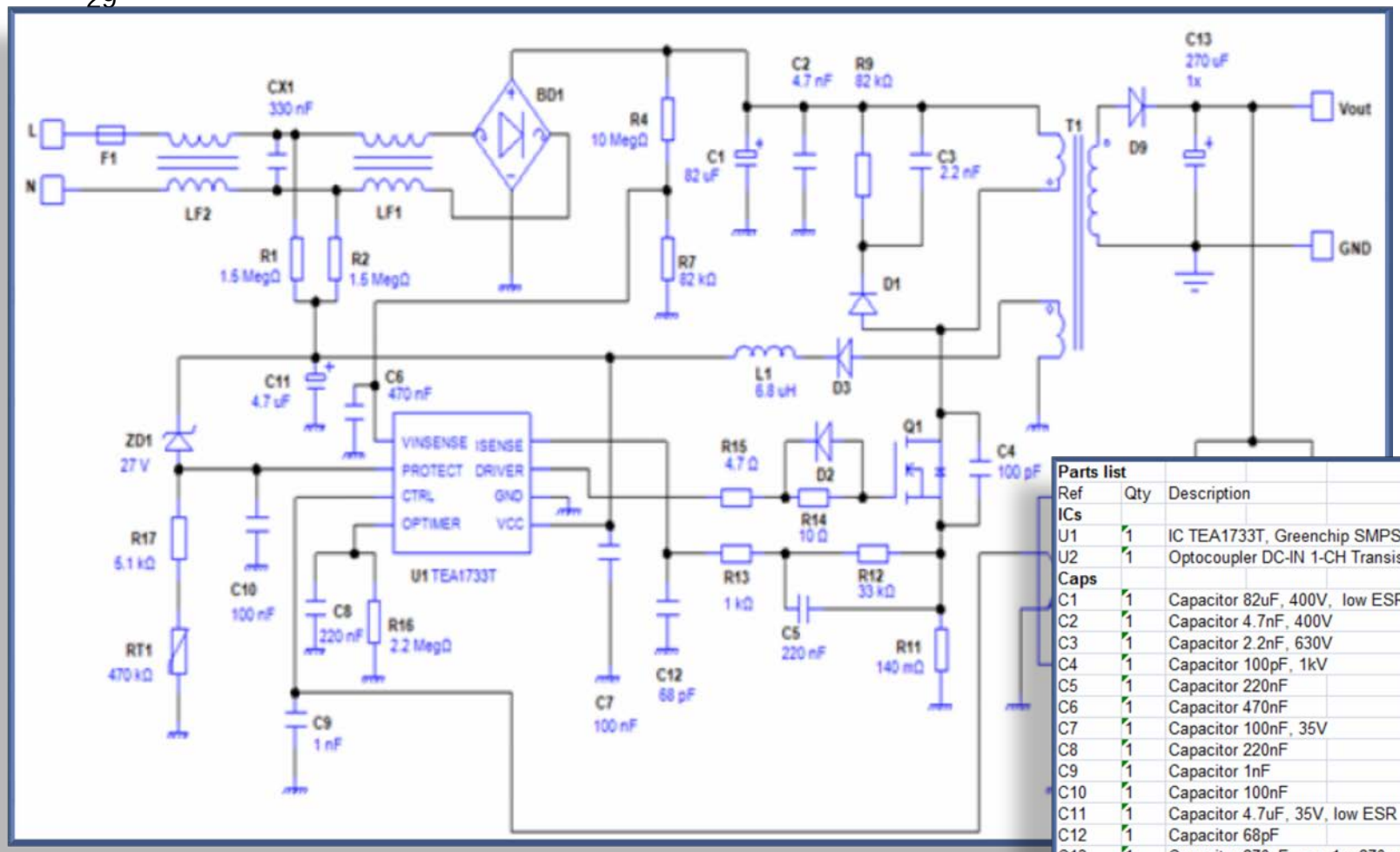
Are we done?

Vo=24V output is desired

- R23 = 44.978 Kohm with the equation
- Closest 1 percent resistor is R23 = 45.3Kohm
- Plug the standard resistor value back into voltage equation
  - Vo = 2.5V + (R23+R24)/R24
  - Vo = 24.15V

1% Resistor Values						
100	140	196	274	383	536	750
102	143	200	280	392	549	768
105	147	205	287	402	562	787
107	150	210	294	412	576	806
110	154	215	301	422	590	825
113	158	221	309	432	604	845
115	162	226	316	442	619	866
118	165	232	324	453	634	887
121	169	237	332	464	649	909
124	174	243	340	475	665	931
127	178	249	348	487	681	953
130	182	255	357	499	698	976
133	187	261	365	511	715	
137	191	267	374	523	732	

Design Tool Output



Parts list		
Ref	Qty	Description
ICs		
U1	1	IC TEA1733T, Greenchip SMPS Control IC
U2	1	Optocoupler DC-IN 1-CH Transistor DC-OUT 4-Pin Mini-Flat T/R
Caps		
C1	1	Capacitor 82uF, 400V, low ESR
C2	1	Capacitor 4.7nF, 400V
C3	1	Capacitor 2.2nF, 630V
C4	1	Capacitor 100pF, 1kV
C5	1	Capacitor 220nF
C6	1	Capacitor 470nF
C7	1	Capacitor 100nF, 35V
C8	1	Capacitor 220nF
C9	1	Capacitor 1nF
C10	1	Capacitor 100nF
C11	1	Capacitor 4.7uF, 35V, low ESR
C12	1	Capacitor 68pF
C13	1	Capacitor 270uF, e.g. 1 x 270 or 2 x 150 uF, 35V, Iripple > 1.04A
C16	1	Capacitor 10nF
CX1	1	Capacitor 330nF, X capacitor
CY1	1	Capacitor 2.2nF, Y capacitor
Diodes		
BD1	1	Bridge Rectifier Vr = 600V, IF = 300mA
D1	1	Diode SA2M
D2	1	Diode BAS316 (NXP), Or BAS16 (NXP)
D3	1	Diode BAS321 (NXP), Or BAS21J (NXP)
D9	1	Diode Schottky, Iav > 2.5A, VR > 400V
ZD1	1	Zener Diode 27V, Or BZX84-C27 (NXP)

Design Tool Output

Transformer

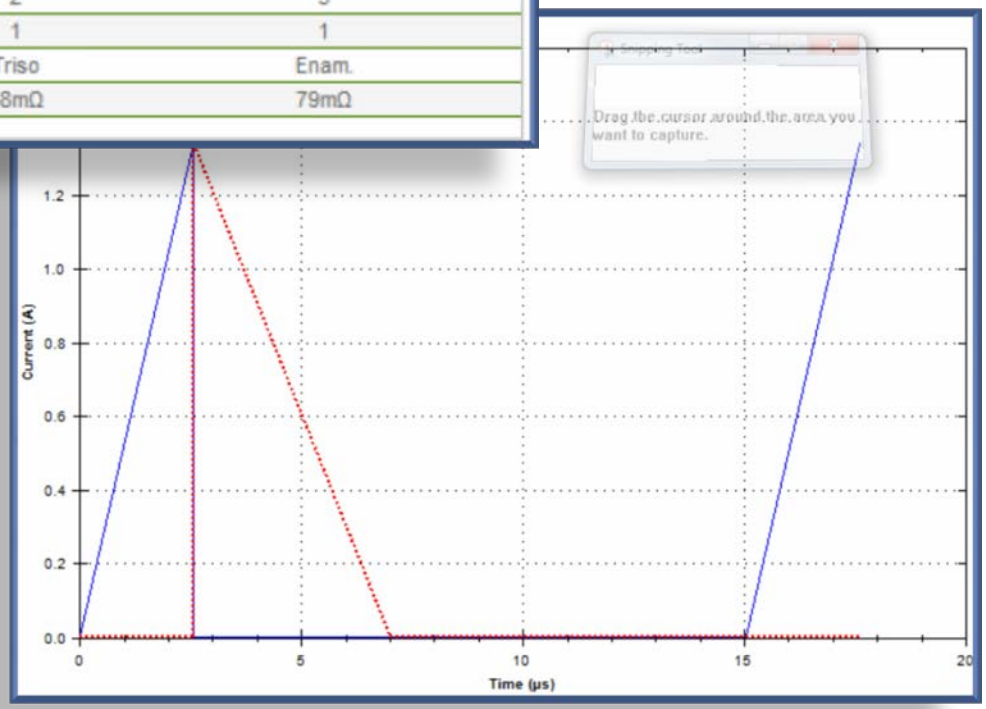
Core type/size	RM12/I	Output power for CCM (at min.	51 W
Primary inductance	224 µH	Winding ratio (Nprim/Nsec)	2.76
Primary turns	24	NVout	68 V
Secondary turns	9	Total transformer losses	155 mW

Current sense resistor

Selected current sense resistor	140 mΩ	Max. peak output power (at min.	74 W
Max. output power (at min mains)	64 W		

Windings

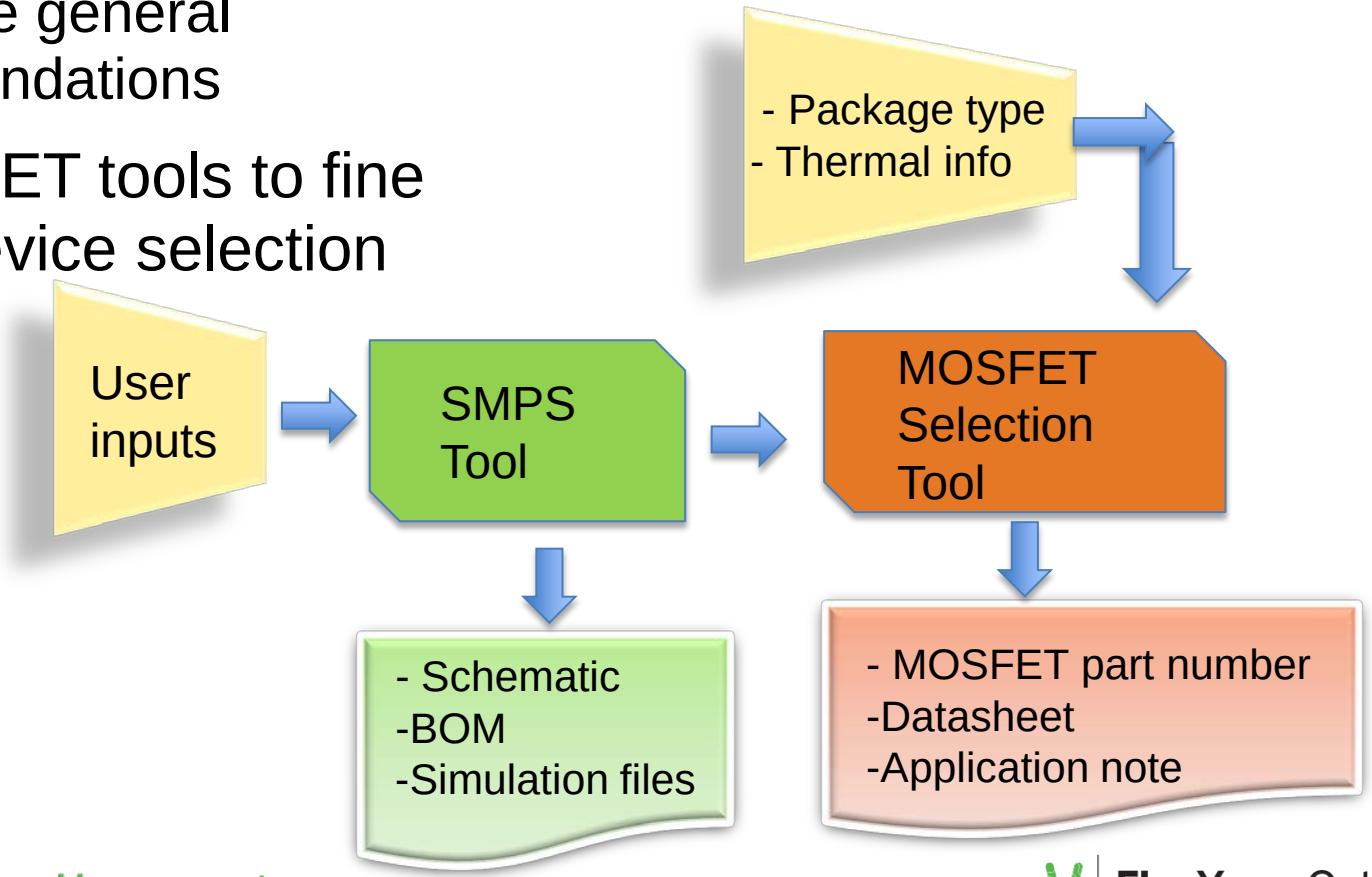
	Primary	Secondary	Auxiliary
Number of turns	24	9	8
Copper diameter	0.381mm (26.5 AWG)	0.450mm	0.241mm (30.5 AWG)
Overall diameter	0.419mm	0.675mm	0.272mm
Nr of parallel wires	1	2	3
Number of layers	1	1	1
Wire type	Enam.	Triso	Enam.
DC resistance	285mΩ	38mΩ	79mΩ



Power Management

MOSFET selection

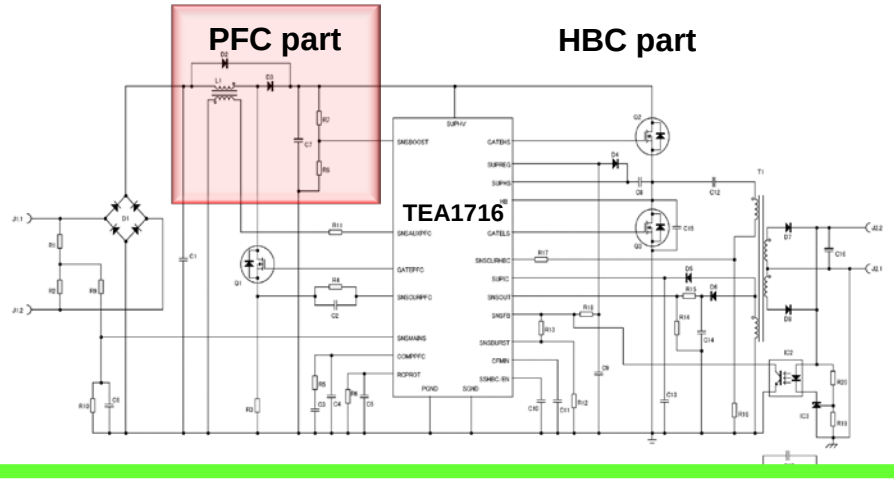
- Recommended device
  - CAD tool provides specifications
  - These are general recommendations
- Use MOSFET tools to fine tune the device selection



High Efficiency Power Management

TEA1716 (75W <x< 500W) – Reference Design

EXAMPLE



200W LLC adapter 19.5V/10.25A

Typical Applications

- Medical Power Supplies
- Garage Door Openers
- Industrial Ethernet switch PSU, industry PC PSUs, rail power

Strategic Advantages for AC/DC

- Highly efficient over wide load conditions
  - MEGA Shottky have low Vf
  - GreenChip designed for wide load conditions
  - BISS is 8x more efficient with lower VCEsat
  - Power Diodes have low leakage
  - Power Diodes reduce switching losses in MOSFET or IGBT
- Primary sense for low wattage applications
  - No opto couplers required
  - Reduces PCB area and cost

Strategic Advantages for AC/DC (pg 2)

- Better reliability
  - Components run cooler when they are efficient
  - Clip bond technology versus wire bonding
  - BISS has lower VCEsat which runs cooler
  - Power diode reduces switching loss in the MOSFET or IBGT
  - GreenChip have over power timer to protect device
- Higher power density
  - Clip bond package dissipates more heat

How to do a design

- Variety of power tools are available
- Free simulation results
- Demo boards are available
- Enter a design and get started!

Power Selection Guide

AC/DC Conversion

- GreenChip
  - High eff at wide load range
  - Designs up to 500W
- Discretes
  - BISS
  - MEGA Shottky
- Power Diodes
  - NUR460P, BYC30X
  - 600V ultra low leakage
  - Reduces switching losses in MOSFET or IGBT

DC/DC Conversion

- LDO
  - LD68x***y***
  - Low in rush and soft start
- DC/DC
  - DCMx
  - High eff at wide load range
- GreenChip
- Discretes
  - BISS
  - MEGA Shottky
- Power MOS
  - PSMNx, BUFKx
  - Lowest RDSon / High Switching
  - LFPAK56, LFPAK33
  - Best in class current and avalanche

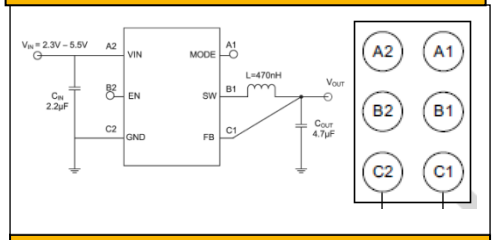
Switches and External Devices

- PFC
  - BYCx, BYVx, BYRx, BYWx
  - Optimized for PFC
- MOSFETs
- Load switches
- ORing MOSFETs

PL Standard Linear

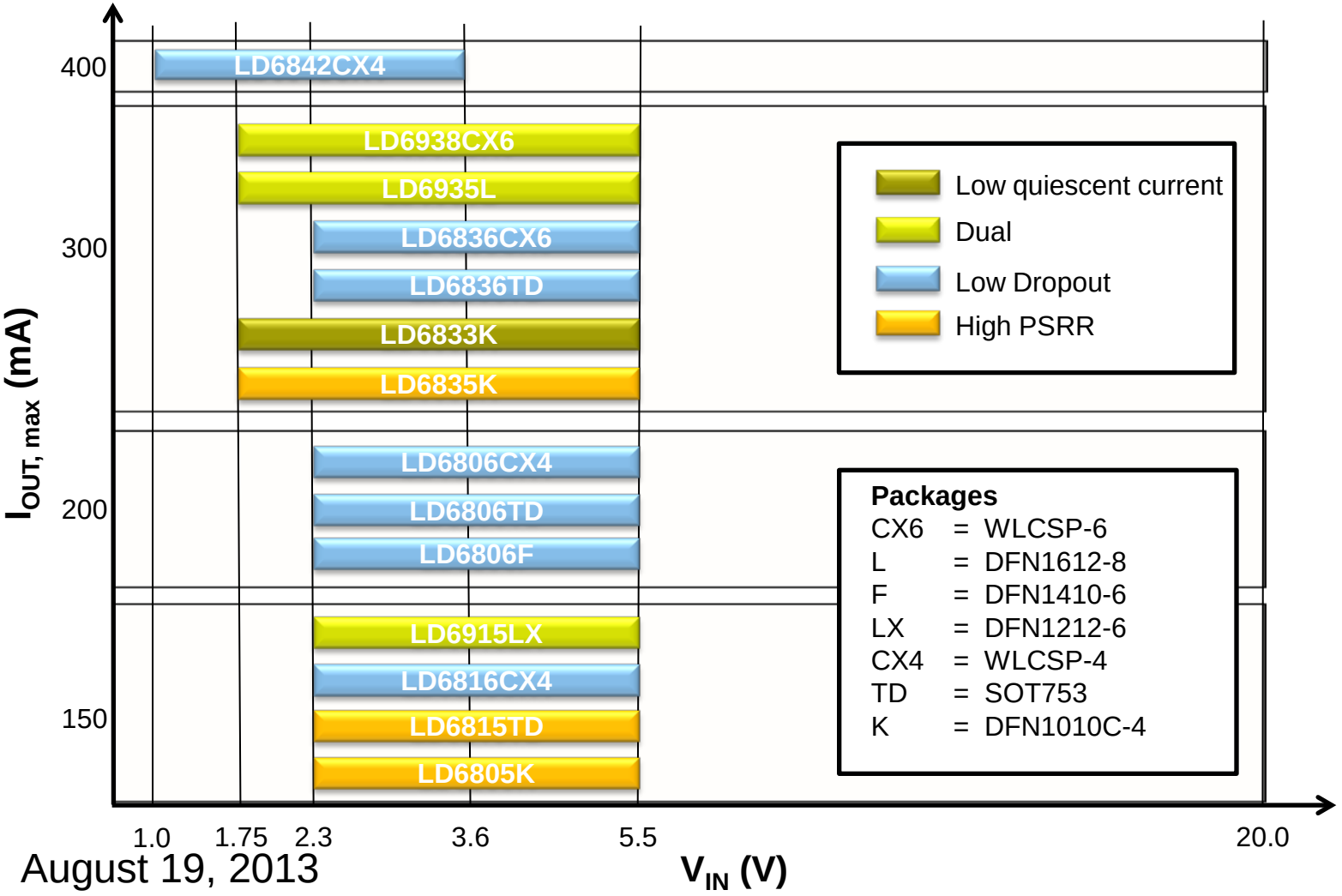
37 Product Portfolio Overview

Product family insights !

	DC/DC	Ultra low drop out LDOs (< 6V)	Shunt regulators
Voltage Regulators			
	• Buck converter • Boost converter • Buck/Boost Converter	• High PSRR • Ultra low drop out • Low quiesccent • Dual LDOs	• Shunt regulators TL431
Signal Conditioning & ESD protection	• HDMI Transmitter IP4786, IP4788 • SD3.0 IP4855, IP4755		

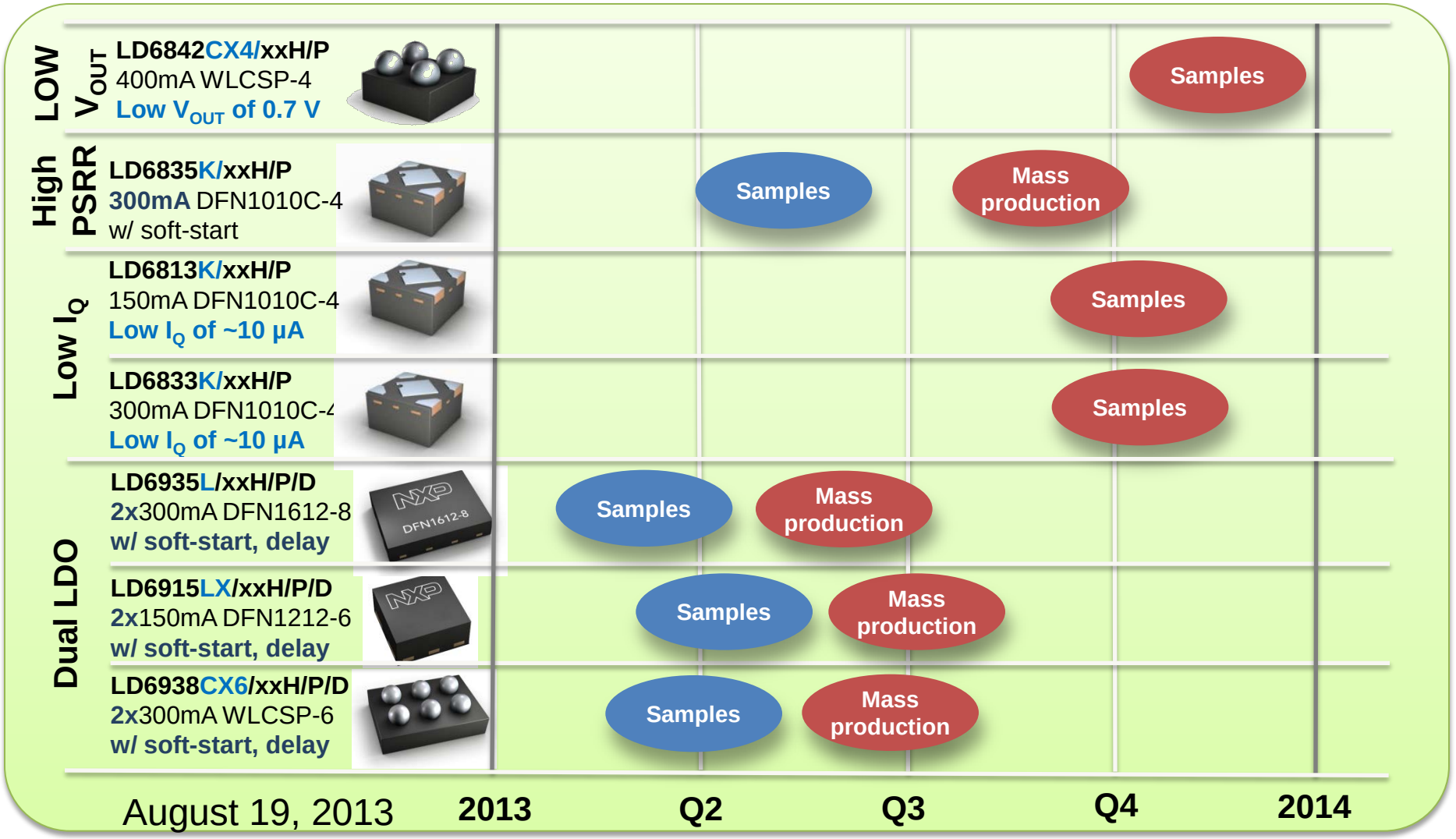
Low-Voltage LDO Product Portfolio

Graphical overview



Low-Voltage LDO Product Portfolio

New Product Introduction

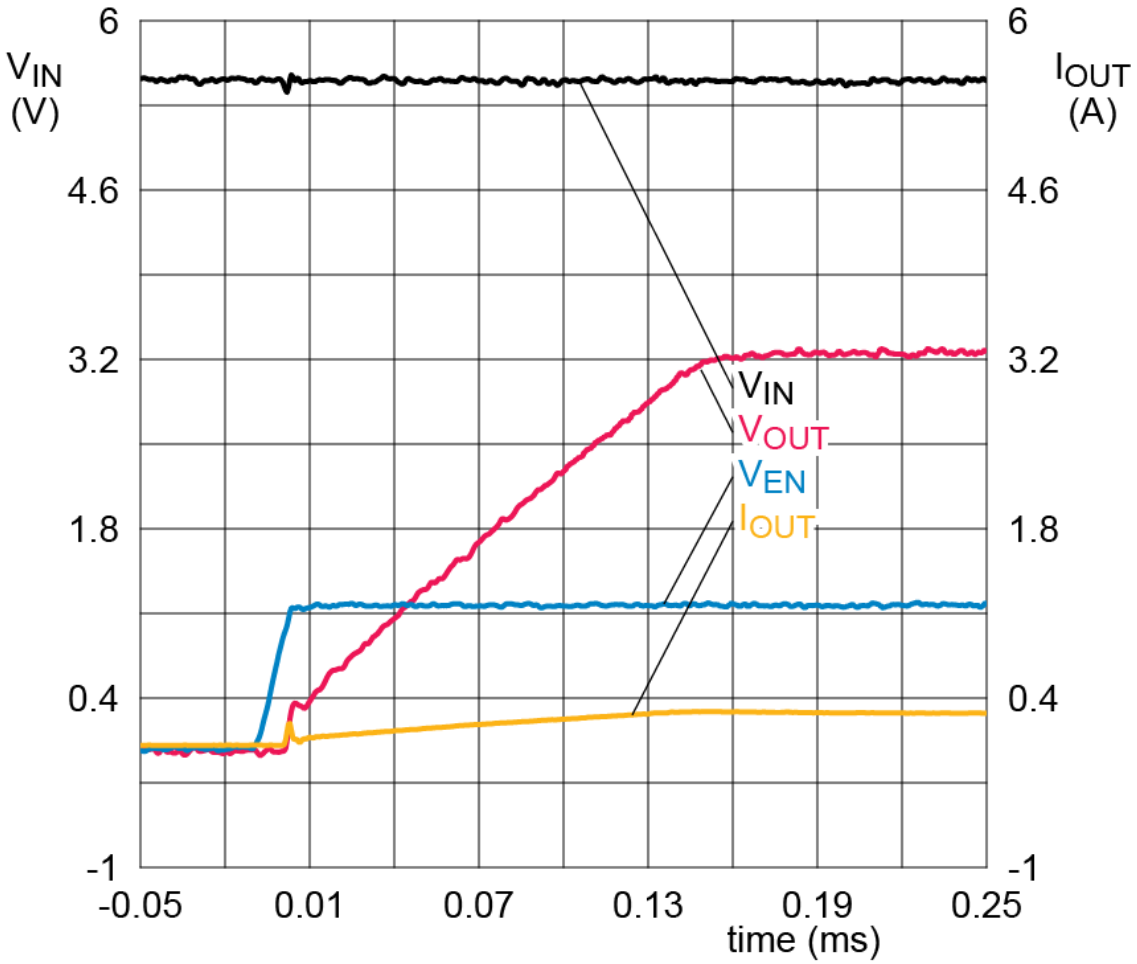


Power Management

Five Years Out

Available | Planned

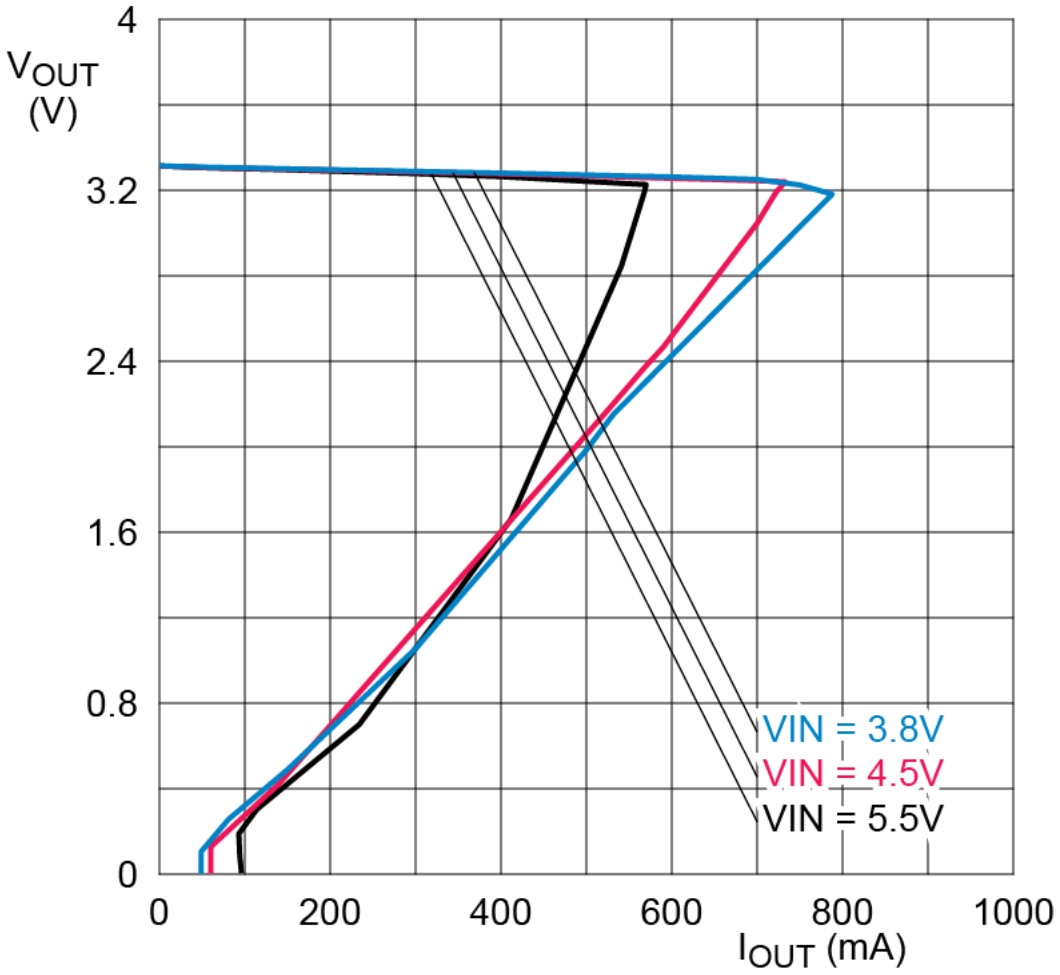
New features: Soft Start (LD6835, LD6935 & LD6938)



The soft start function limits the inrush current by maintaining a defined start up time of 150 µs.

Special for applications supporting a connector the maximum load at the connection is limited.

New features: Fold-back (LD6835, LD6935 & LD6938)

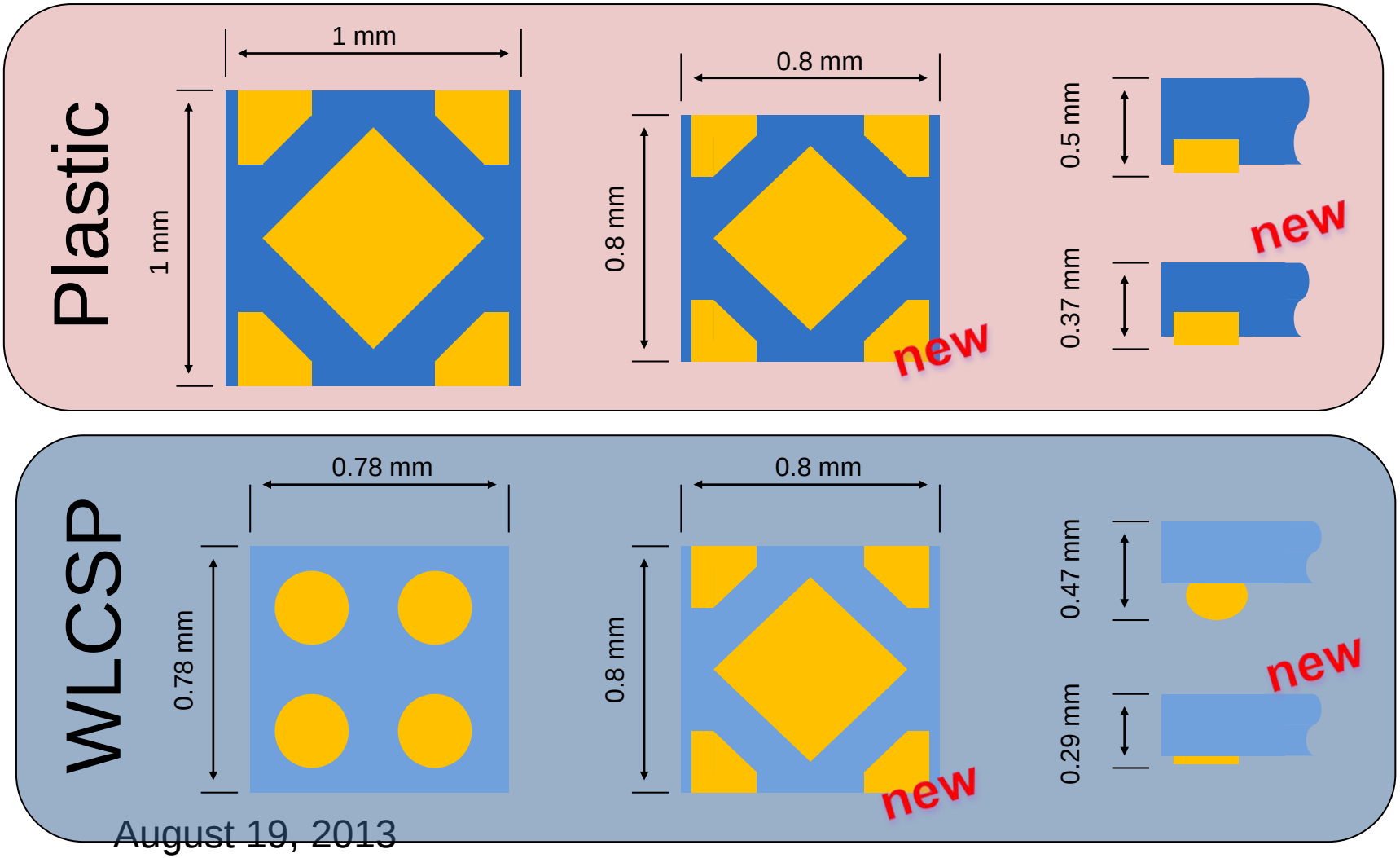


The fold back current limiter controls the maximum power at a hard shortage to ground.

For supply lines to a connector e.g. accessories this functions helps to minimize the heat up even at a hard shortage to ground.

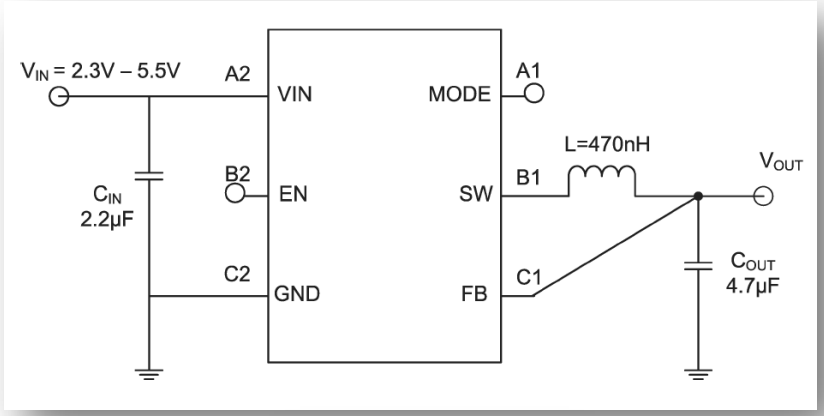
The power dissipation is reduced by a factor of 6.

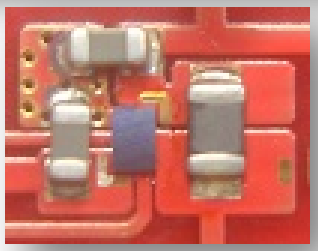
Development news: *new Package Options*

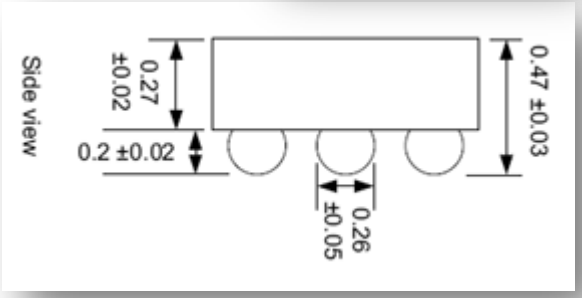


August 19, 2013

DC/DC buck converter: *DC3/6/9M Series - Overview*

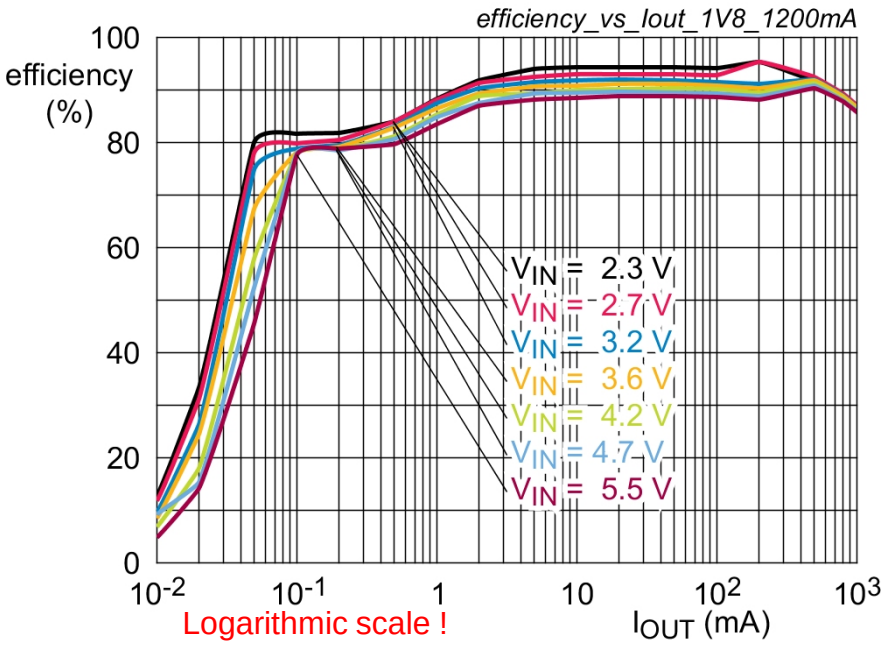






- High efficiency at 6 MHz operation
- High operating input voltage range **2.3 V - 5.5 V** (6.0 V peak)
- **1.2 V** to **2.85 V** output voltage range
- **425 mA**, **500 mA** and **650 mA** DC output current versions available
- Low quiescent current in shut-down mode **1 µA**
- **Low output voltage ripple** in PWM and PFM mode
- XSHUTDOWN signal output version available (power good indicator for clock enable version)
- Enable via high-active or a clock signal (depends on sub-version)
- Short circuit and over-temperature protection
- **Integrated ESD** protection according to IEC 61000-4-2, level 4
- Pb-free, RoHS compliant and free of Halogen and Antimony (dark green compliant)
- **WLCSP** with 0.4 mm pitch

44 Efficiency for DC3MA12/18

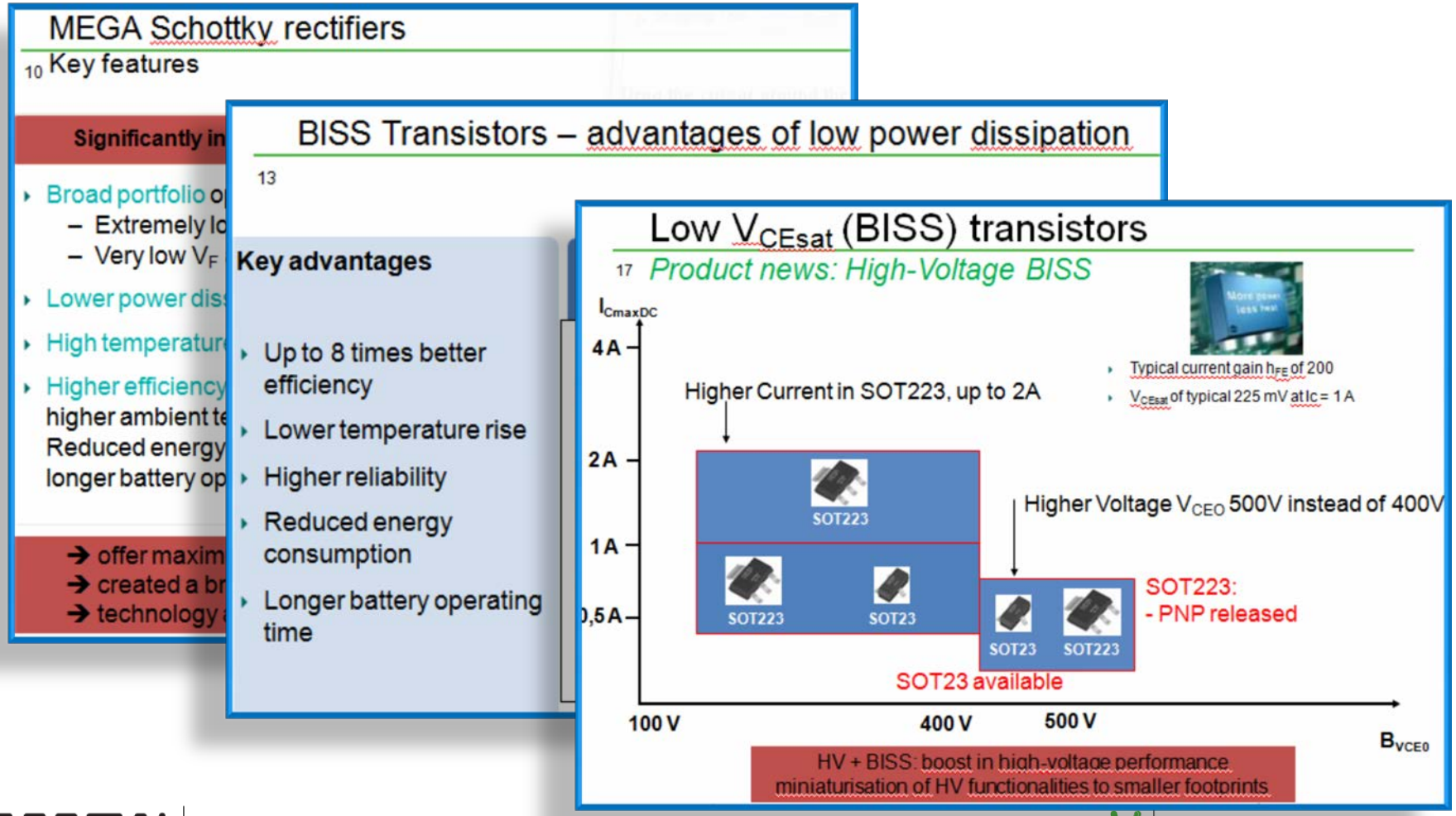


High efficiency @ light load

- 95% top efficiency
- Constant and more than 90% efficiency over a wide current range from 2 to 700mA
- Very high efficiency down to very low current of 0.1mA
- High maximum current of 1200mA
- low quiescent current of typically 25µA
- DFN2020-6 plastic package

Discrete Devices

- Already covered in AC/DC section



General Survey SMPS ICs

GreenChip

typ. applications	PFC control	primary control	secondary control	STBY control
Resonant typ. >90W	TEA171x (TEA1716) (Greenchip Resonant)		TEA1791A TEA1795 (Greenchip SR)	Parallel supply TEA173x (GreenChip LowPower)
Flyback >75W	TEA175x(TEA1750/51/52/TEA1753/55) (Greenchip III)		TEA176x (TEA1761/62)	TEA1703 (Greenchip Standby)
Flyback <75W	n.a.	TEA153x (TEA1530/TEA1532/33) TEA155x (TEA1552) (QR FLB diff. f_{osc}) (Greenchip II) TEA173x (TEA1731/33/38) (Greenchip III; LP)	TEA179x (TEA1792) (Greenchip SR)	
Flyback <15W	n.a.	TEA172x (TEA1721/3) (Greenchip SP)	n.a.	Integrated in Primary IC

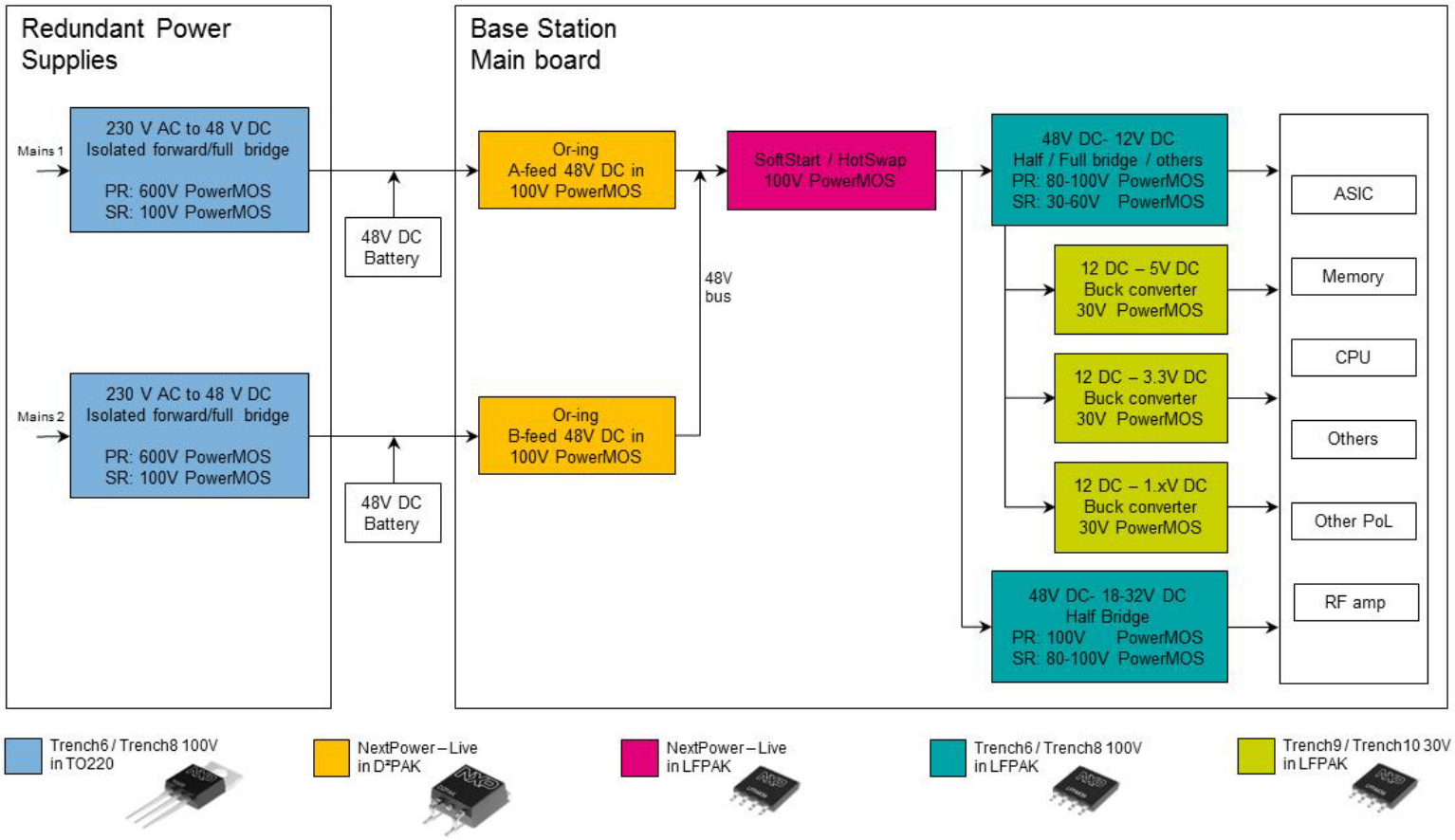
Probably not suitable due to PFC

12V to 30V input flyback controller

High Efficiency Power Management

Telecom Industrial Power Supply (48V Bus DC/DC)

EXAMPLE



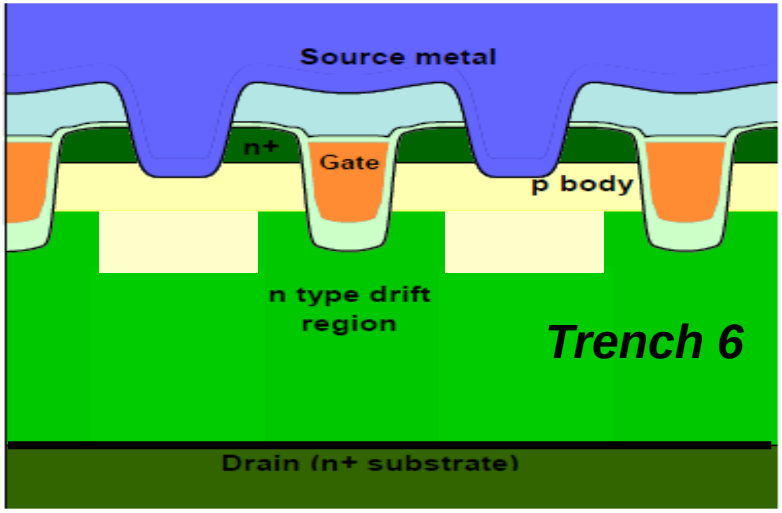
NextPower – Superjunction advantage

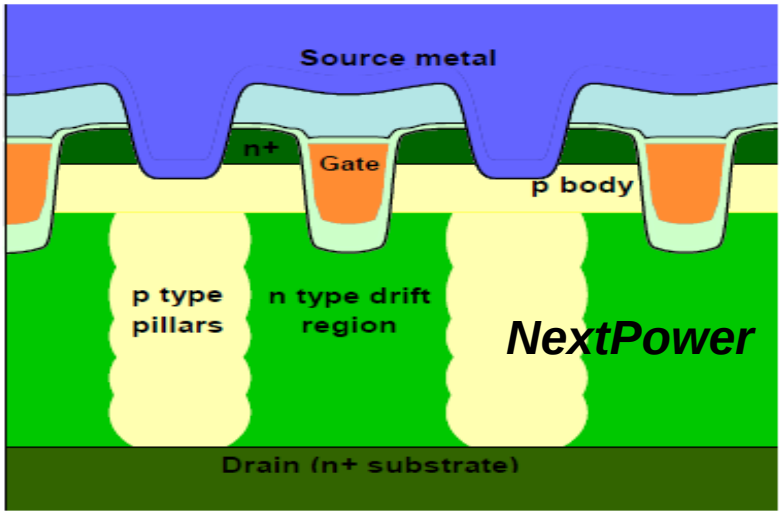
- NXP (Philips Research) was the pioneer of Resurf / Superjunction Technology
- NextPower extends Superjunction capability beyond competitor's TrenchMOS structures

Deeper junctions → lower on resistance per cell

Fewer cells → improved switching efficiency

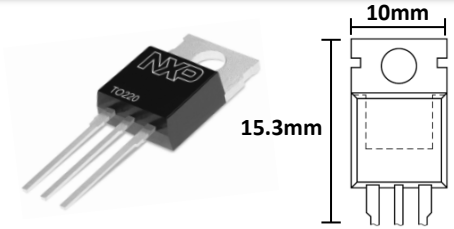
Lower cell density → best-in-class SOA & I_D current rating





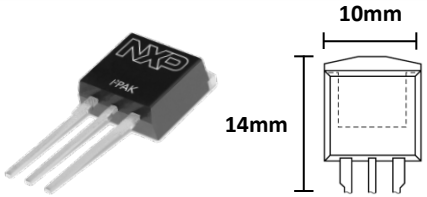
Package Overview – StdMOS

TO220



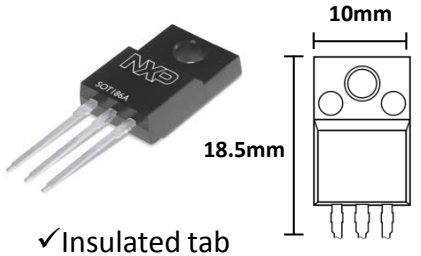
- ✓ Best thermal performance
- ✓ Through hole

I²PAK



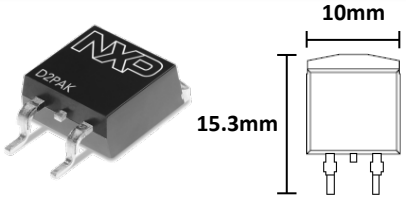
- ✓ Very low R_{DSon}
- ✓ Very high current

TO220F



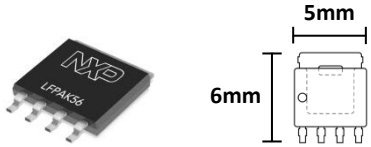
- ✓Insulated tab
- ✓ Reduced assembly cost
- ✓Thin-pin compatible (1.4mm)

D²PAK



- ✓ Best thermal performance
- ✓ Surface mount

LFPAK56



- ✓ Robust clip construction
- ✓ Low R_{DSon}

LFPAK33

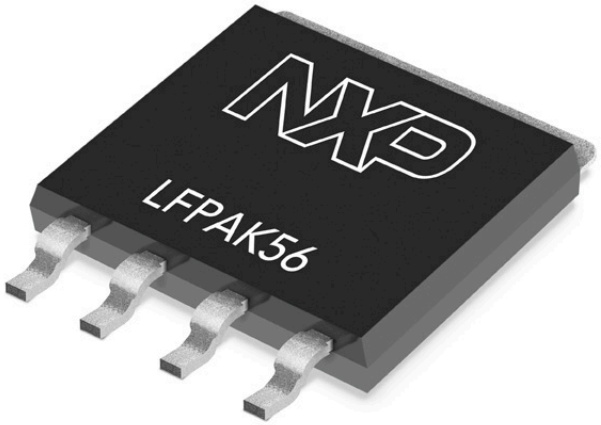
- ✓ Very small outline & slim profile
- ✓Footprint compatible with QFN3333

Note: The dimensions shown above are approximations. For accurate descriptions of the package outlines including tolerances, please refer to the datasheet

Introducing LFPAK

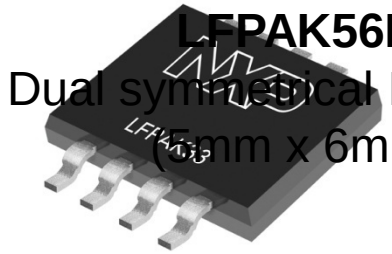
50 *The Toughest Power Package*

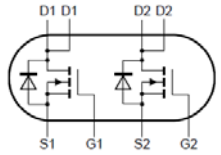
LFPAK56
Power-S08 compatible footprint
(5mm x 6mm)



LFPAK33
QFN/DFN33 compatible footprint
(3.3mm x 3.3mm)

LFPAK56D
Dual symmetrical MOSFET
(5mm x 6mm)





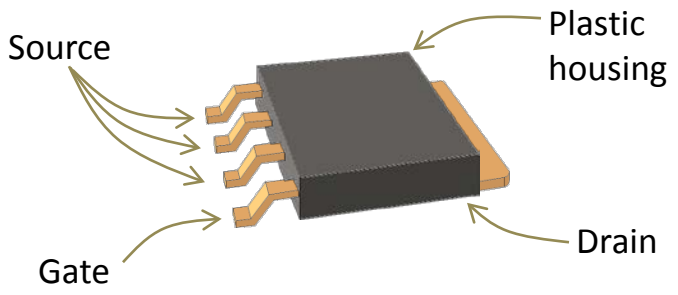
No glue, no wires, no gold,175º C

LFPAK33 - Tougher just got smaller

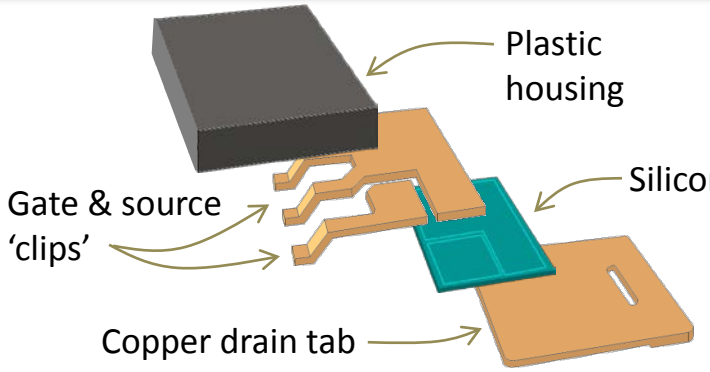
LFPAK56D - Now 2x better

MOSFET Construction

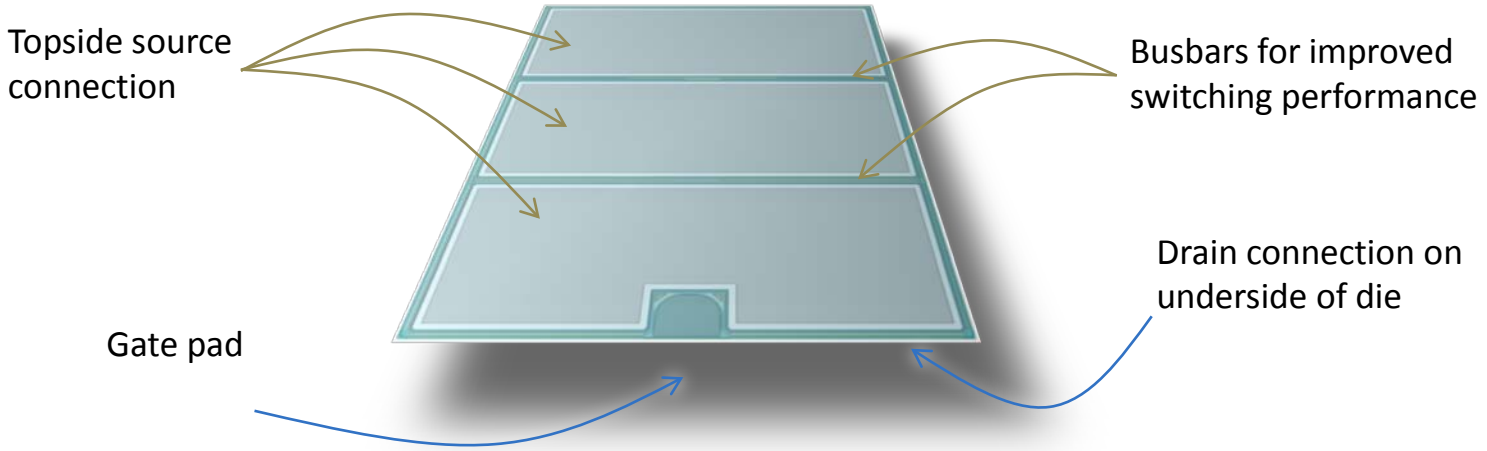
LFPAK Example



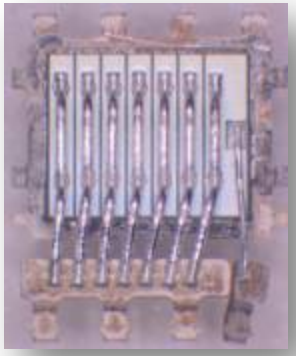
LFPAK Exploded View



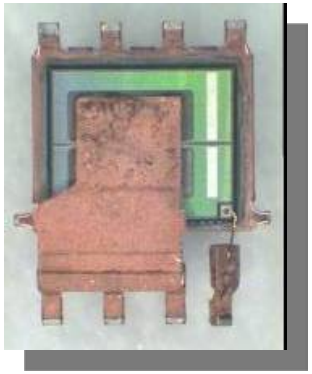
Typical Trench 6 Silicon Die (the MOSFET bit)



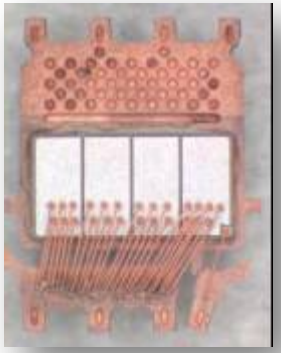
LFPAK – the copper clip advantage



Al wire bonding

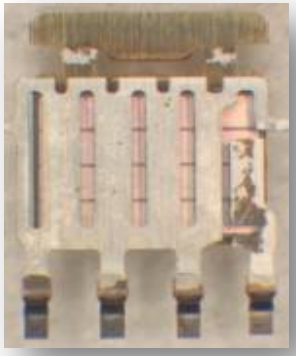


Cu Clip + wire gate

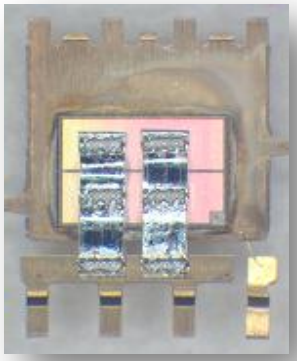


Cu wire bonding

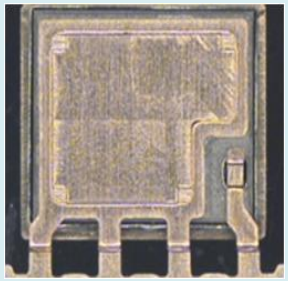
Cu Clip + wire gate



Cu Clip + Au bump



Ribbon Bond



Integrated Cu clip NXP (LFPAK)

Integrated Cu Clip gives

- Low electrical resistance
- Low thermal resistance
- Low Inductance
- High reliability & 175ºC

- 1st power-SO8 to be Auto qualified to AEC-Q101

Source: NXP 2009 analysis

High Efficiency Power Management

Standard PowerMOS – NextPower Cordless

Product family insights !

Professional LFPAK56 (footprint compatible with Power-SO8)

LFPAK56			$R_{DS(ON)}$ (V_{GS} = 10 V)	I_D [max]
30 V	LL	PSMN1R3-30YL	1.3 mΩ	100 A
	LL	PSMN2R0-30YL	2.0 mΩ	
	LL	PSMN2R2-30YLC	2.15 mΩ	
	LL	PSMN2R5-30YL	2.4 mΩ	
	LL	PSMN2R6-30YLC	2.8 mΩ	
	LL	PSMN3R7-30YLC	3.7 mΩ	
40 V	LL	PSMN1R6-40YLC	1.55 mΩ	100 A
	LL	PSMN1R8-40YLC	1.8 mΩ	

Professional TO-220

TO-220			$R_{DS(on)}$ (V_{GS} = 10 V)	I_D [max]
40 V	SL	PSMN1R5-40PS	1.6 mΩ	150 A
	LL	PSMN1R9-40PL	1.6 mΩ	150 A
60 V	SL	PSMN2R6-60PS	2.6 mΩ	150 A
	LL	PSMN2R5-60PL	2.6 mΩ	150 A
	LL	PSMN3R3-60PL	3.4 mΩ	150 A

DIY TO-220

TO-220			$R_{DS(on)}$ (V_{GS} = 10 V)	I_D [max]
40 V	SL			
	LL	PSMN2R1-40PL	2.2 mΩ	150 A
60 V	SL	PSMN3R9-60PS	3.9 mΩ	130 A
	LL	PSMN4R2-60PL	3.9 mΩ	130 A

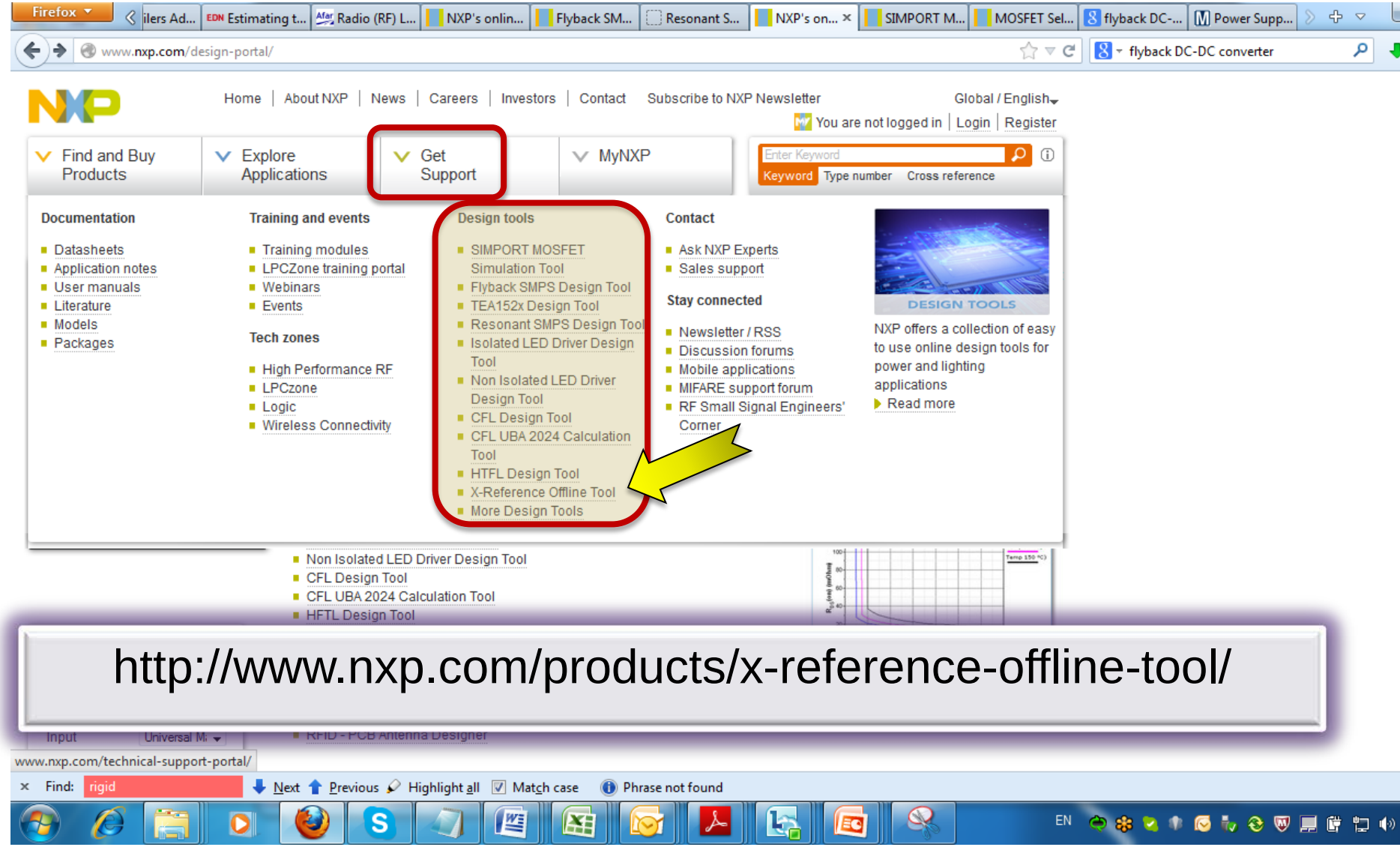
www.nxp.com/nextpower-cordless

Specifically designed for power tool designs

- **ID(max)** – 500 µm diameter internal wires, with multiple bonding, provide up to 150A in TO220
- **Avalanche ruggedness** – Switching highly inductive loads such as motor coils requires PowerMOS able to handle repetitive avalanche events.
- **On resistance** – NXP's low RDS(on) deliver higher efficiencies, ensuring longer battery life and easier thermal management

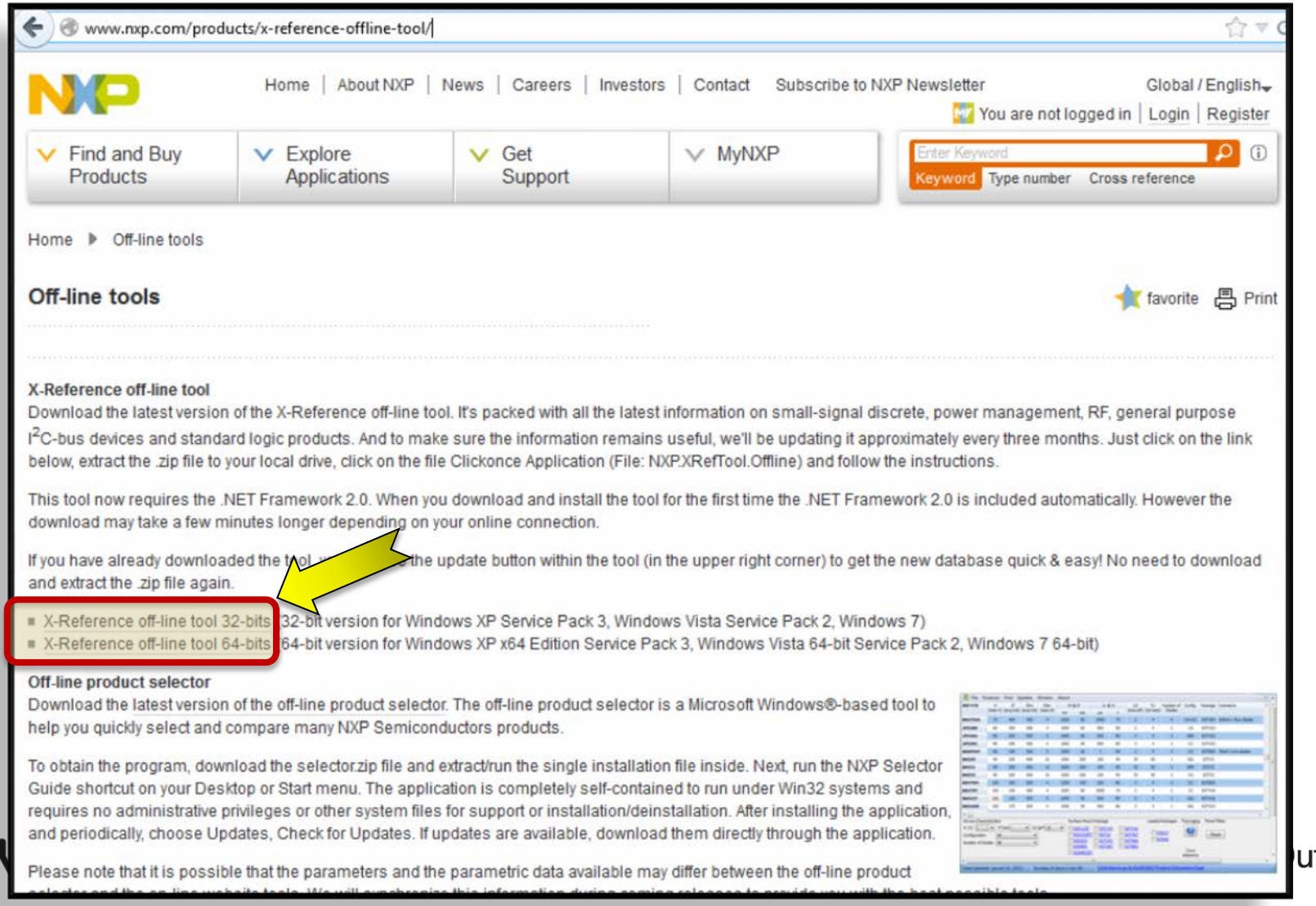
Offline Cross Reference Design Tool

- From the main NXP menu or direct link



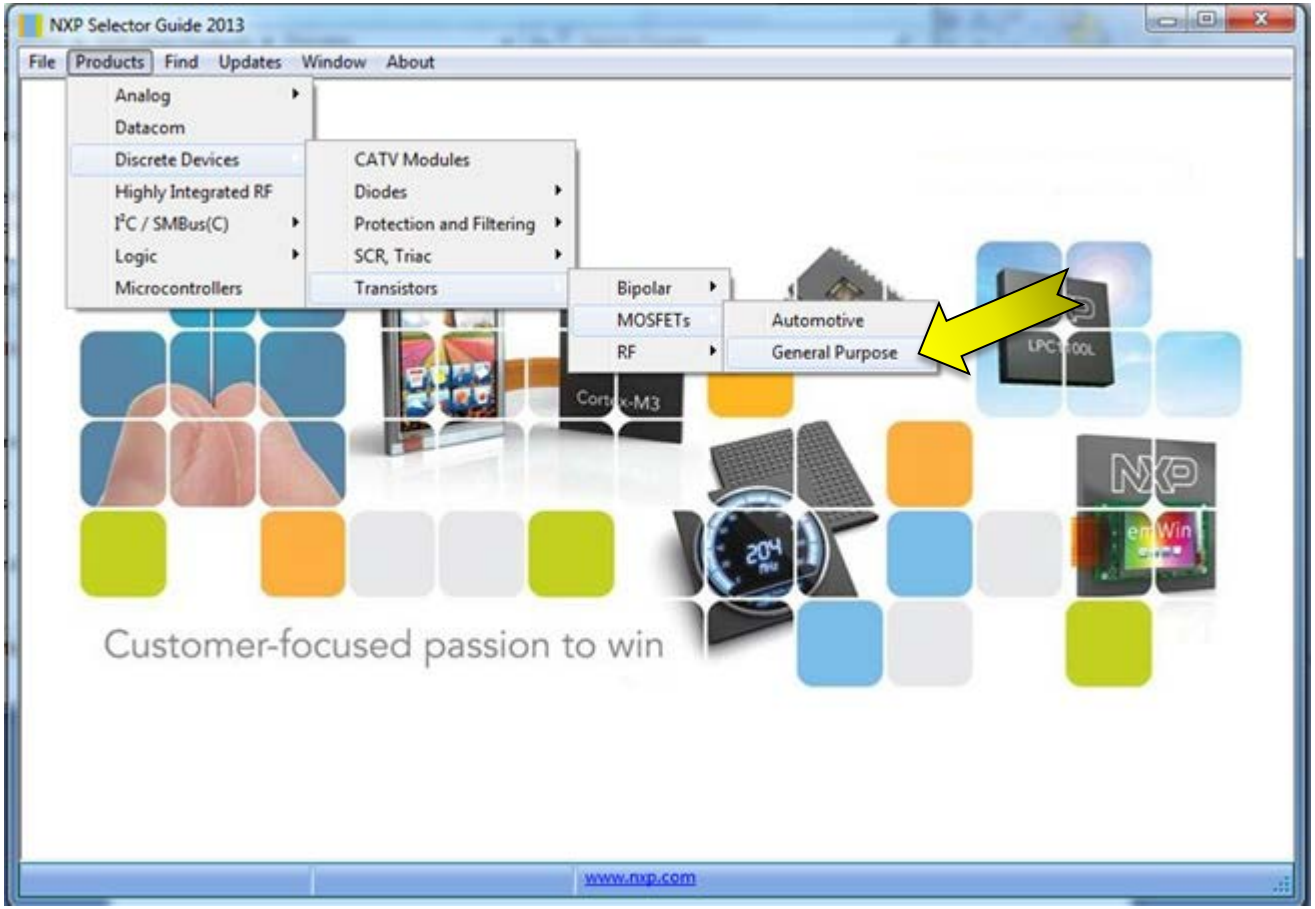
Offline Cross Reference Design Tool

- Click on 32bit or 64bit links



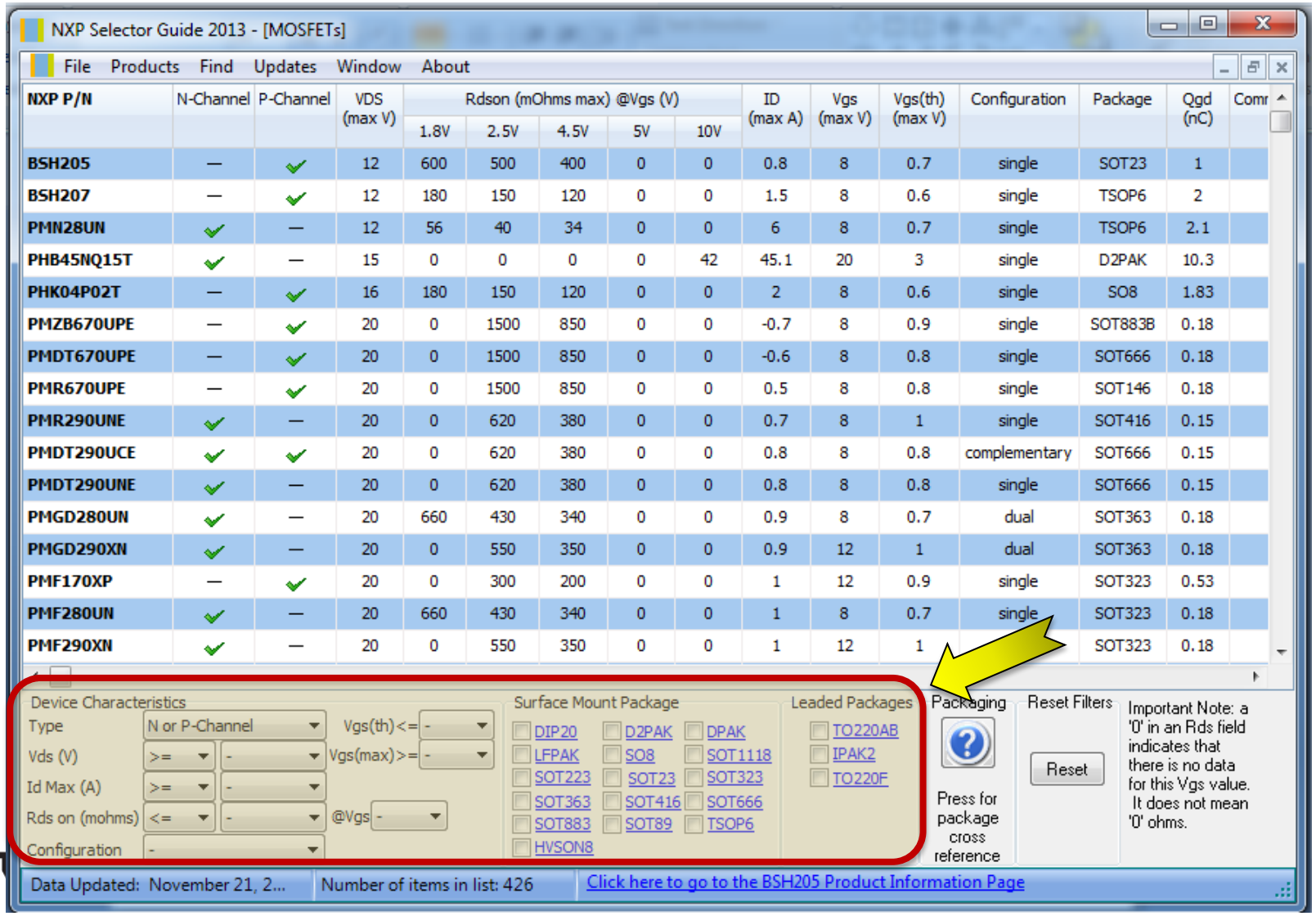
Offline Cross Reference Design Tool

- Run the tool
- Follow the menus



Offline Cross Reference Design Tool

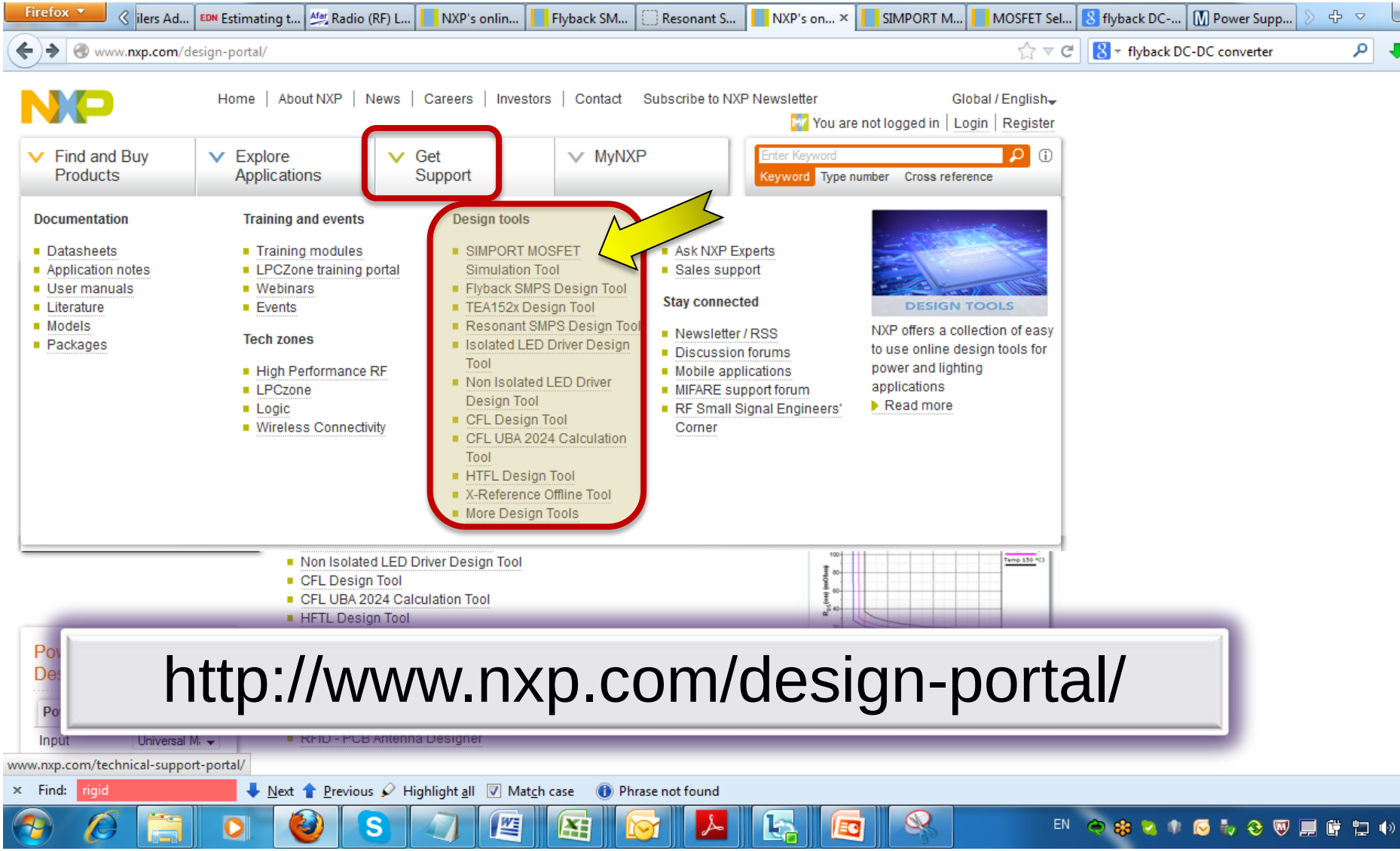
- Lots of devices to select



NXP P/N	N-Channel	P-Channel	VDS (max V)	Rdson (mOhms max) @Vgs (V)					ID (max A)	Vgs (max V)	Vgs(th) (max V)	Configuration	Package	Qgd (nC)	Comr
				1.8V	2.5V	4.5V	5V	10V							
BSH205	—	✓	12	600	500	400	0	0	0.8	8	0.7	single	SOT23	1	
BSH207	—	✓	12	180	150	120	0	0	1.5	8	0.6	single	TSOP6	2	
PMN28UN	✓	—	12	56	40	34	0	0	6	8	0.7	single	TSOP6	2.1	
PHB45NQ15T	✓	—	15	0	0	0	0	42	45.1	20	3	single	D2PAK	10.3	
PHK04P02T	—	✓	16	180	150	120	0	0	2	8	0.6	single	SO8	1.83	
PMZB670UPE	—	✓	20	0	1500	850	0	0	-0.7	8	0.9	single	SOT883B	0.18	
PMDT670UPE	—	✓	20	0	1500	850	0	0	-0.6	8	0.8	single	SOT666	0.18	
PMR670UPE	—	✓	20	0	1500	850	0	0	0.5	8	0.8	single	SOT146	0.18	
PMR290UNE	✓	—	20	0	620	380	0	0	0.7	8	1	single	SOT416	0.15	
PMDT290UCE	✓	✓	20	0	620	380	0	0	0.8	8	0.8	complementary	SOT666	0.15	
PMDT290UNE	✓	—	20	0	620	380	0	0	0.8	8	0.8	single	SOT666	0.15	
PMGD280UN	✓	—	20	660	430	340	0	0	0.9	8	0.7	dual	SOT363	0.18	
PMGD290XN	✓	—	20	0	550	350	0	0	0.9	12	1	dual	SOT363	0.18	
PMF170XP	—	✓	20	0	300	200	0	0	1	12	0.9	single	SOT323	0.53	
PMF280UN	✓	—	20	660	430	340	0	0	1	8	0.7	single	SOT323	0.18	
PMF290XN	✓	—	20	0	550	350	0	0	1	12	1		SOT323	0.18	

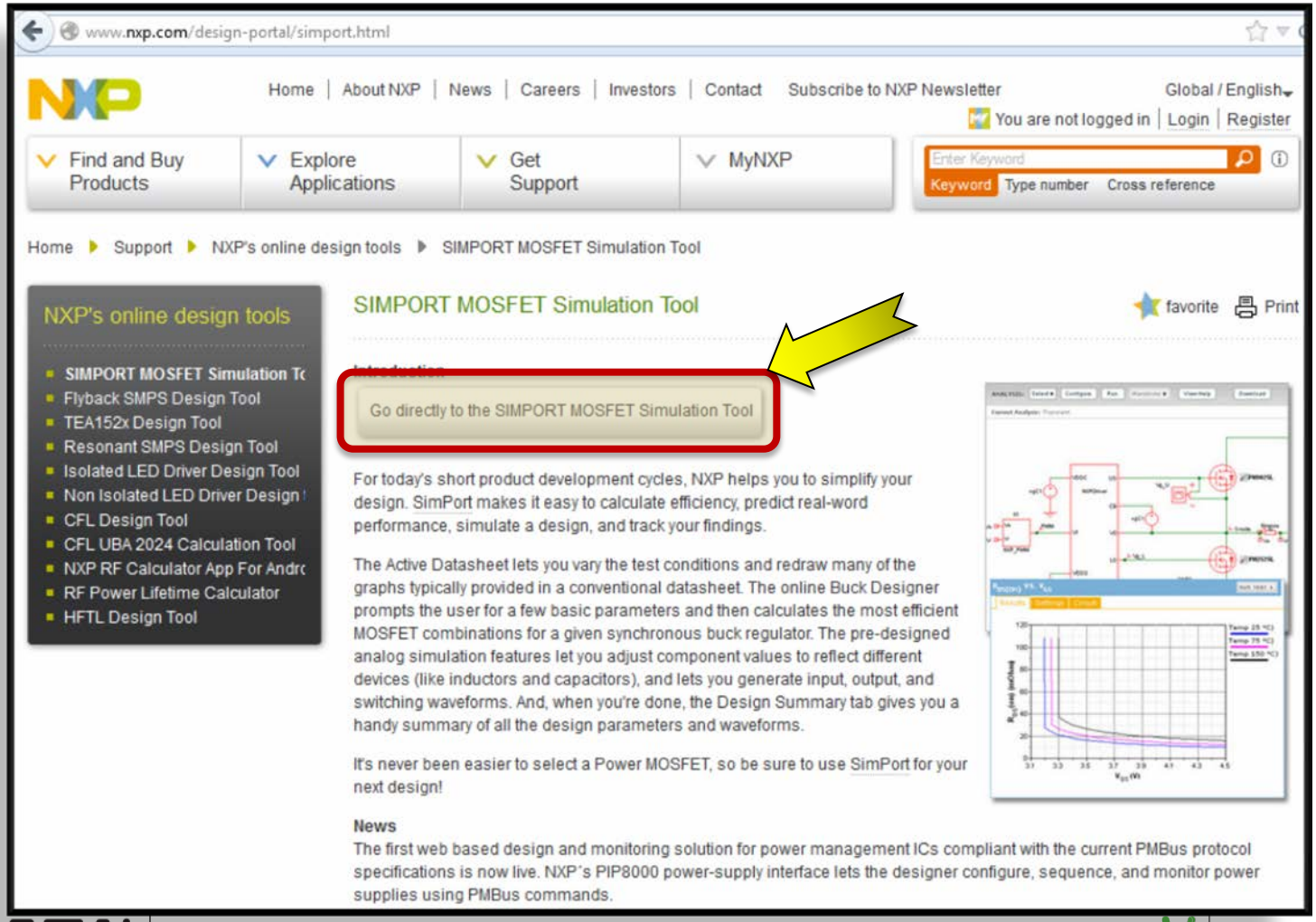
MOSFET Selection and Simulation Tool

- From the main NXP menu or direct link



MOSFET Selection and Simulation Tool

- Select the link



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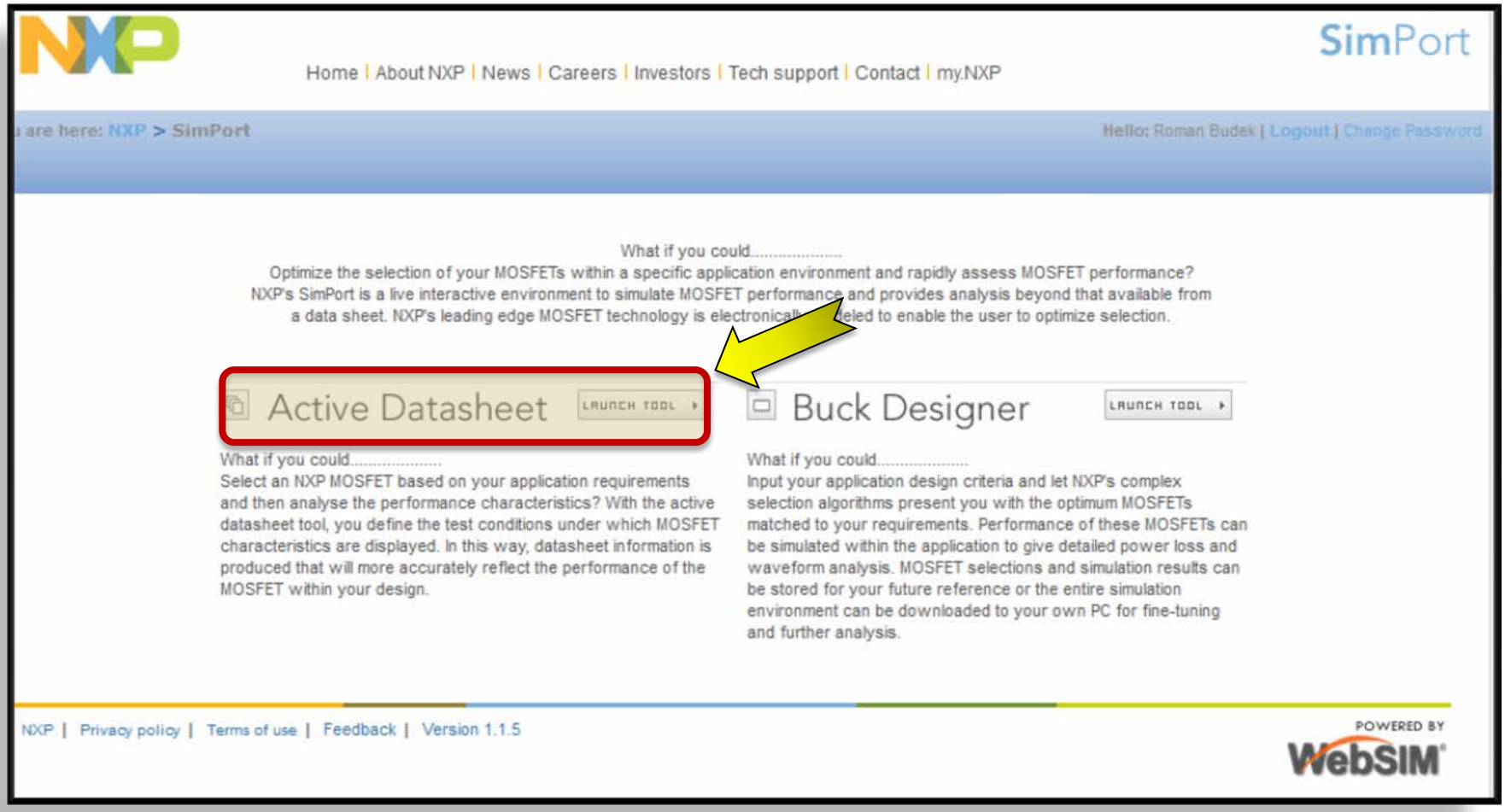
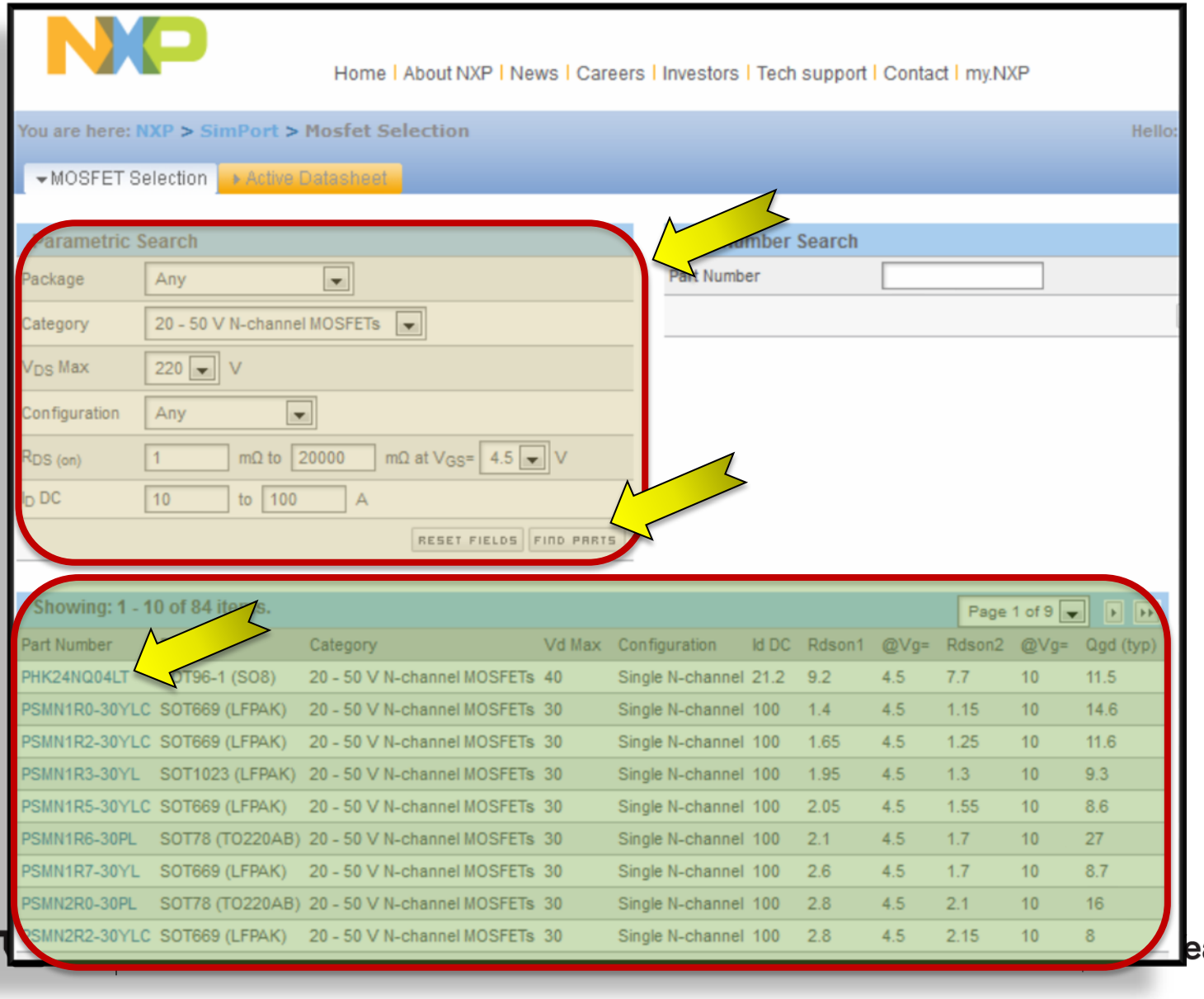
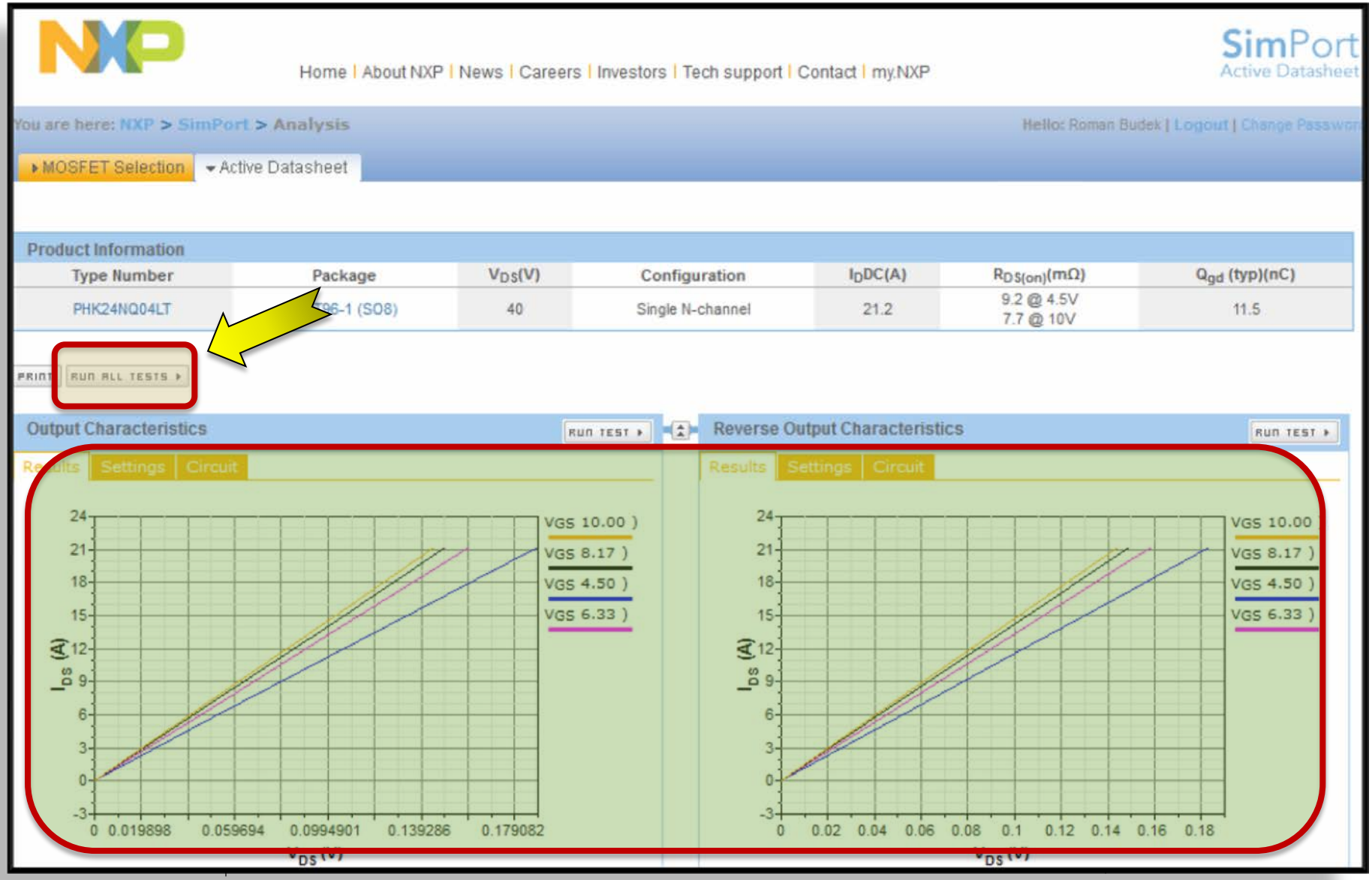
- Select the link



MOSFET Selection and Simulation Tool

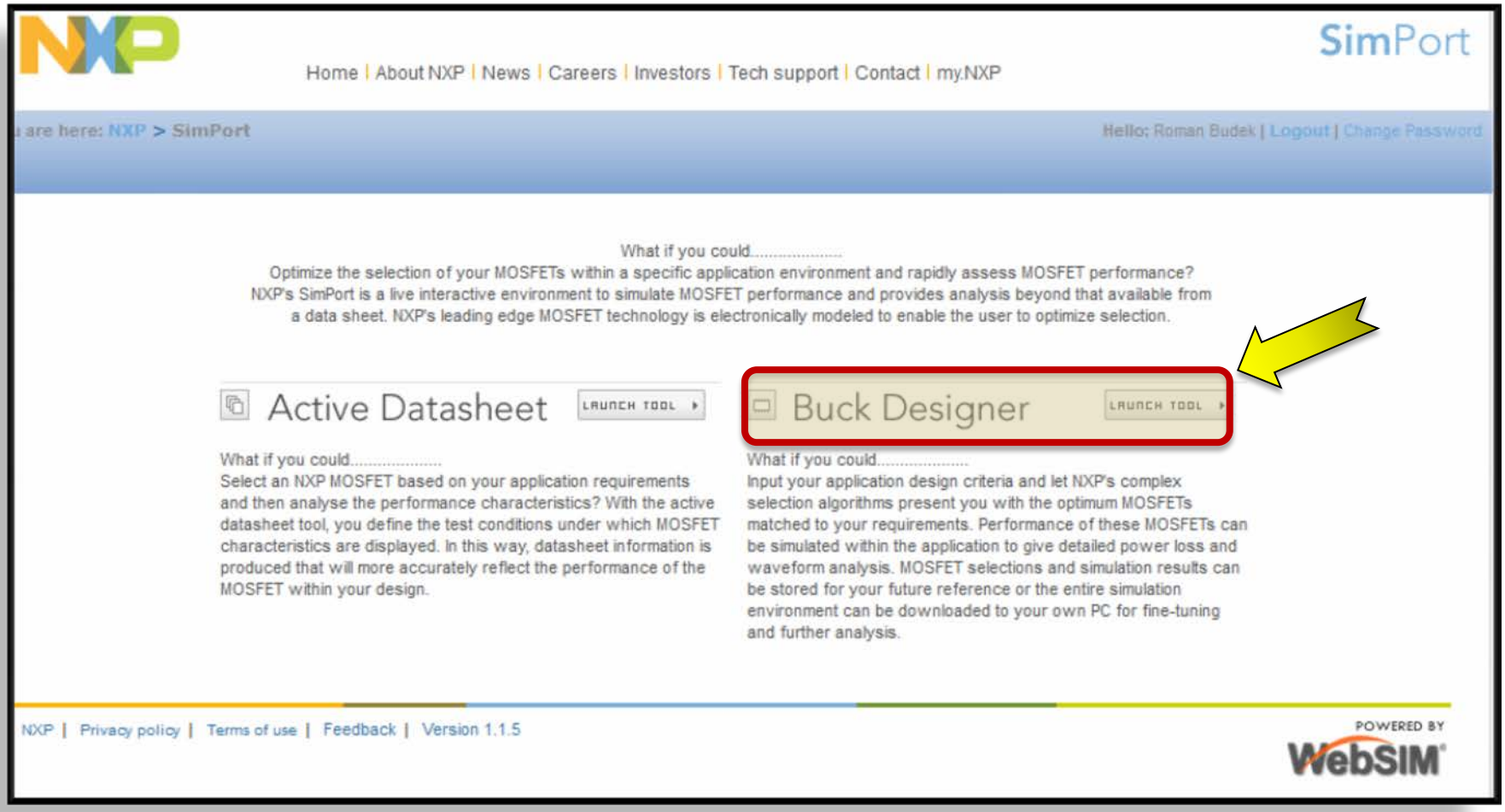


MOSFET Selection and Simulation Tool

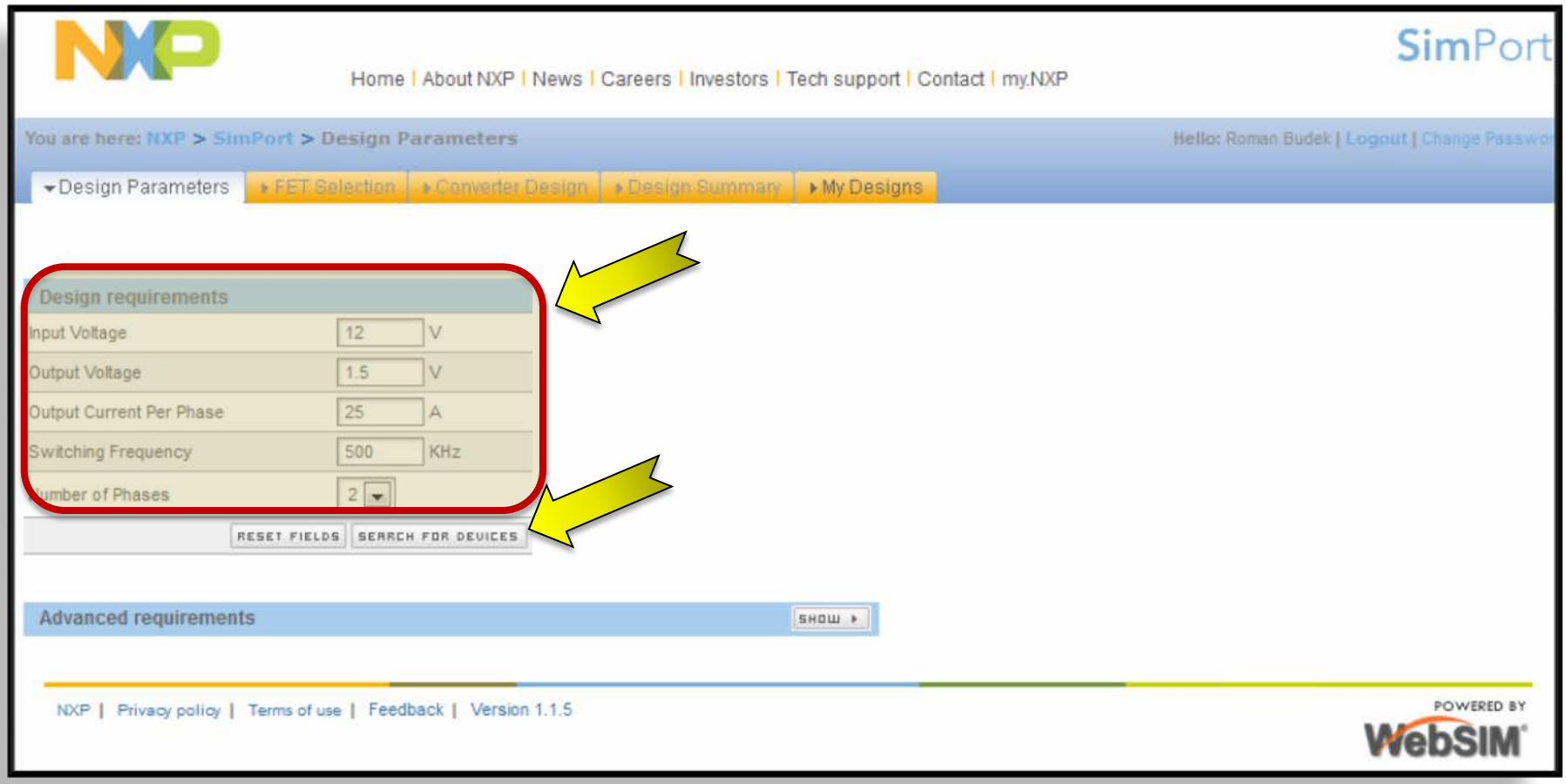


MOSFET Selection and Simulation Tool

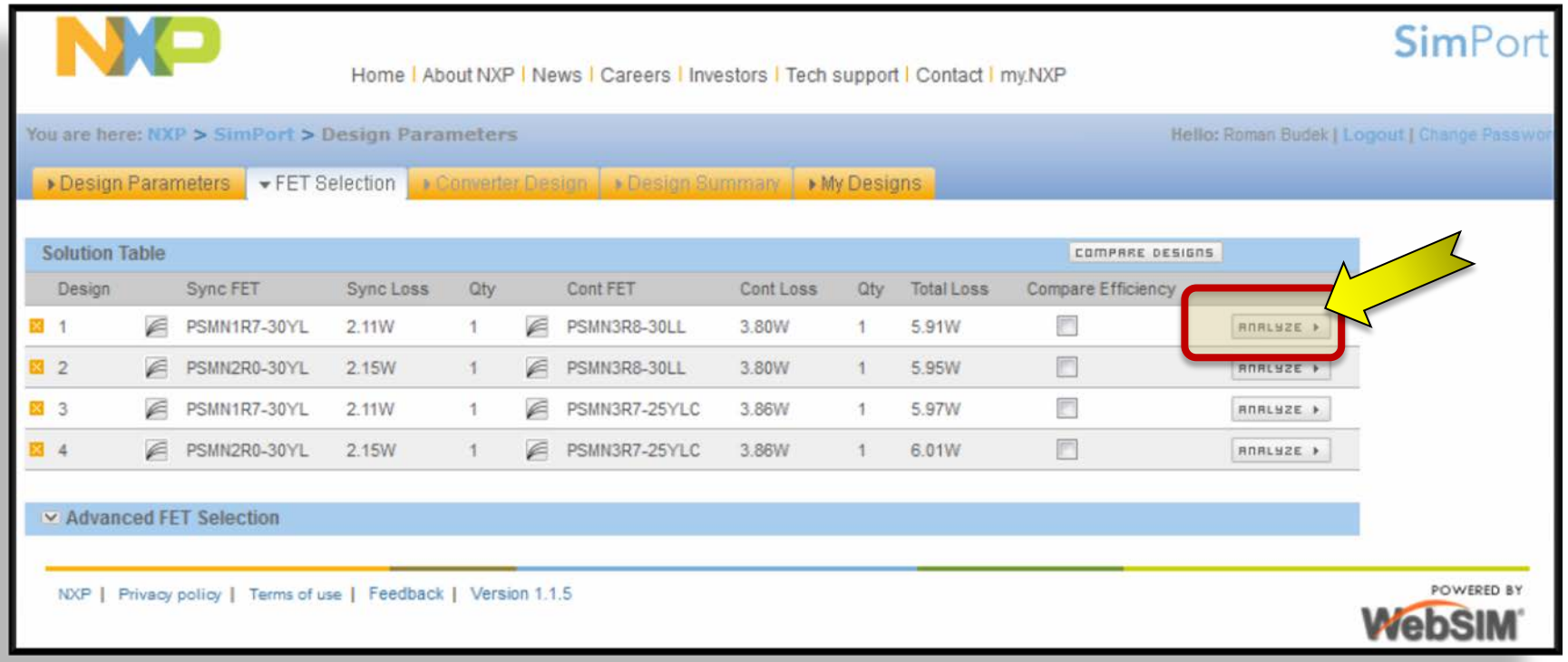
- Select the link



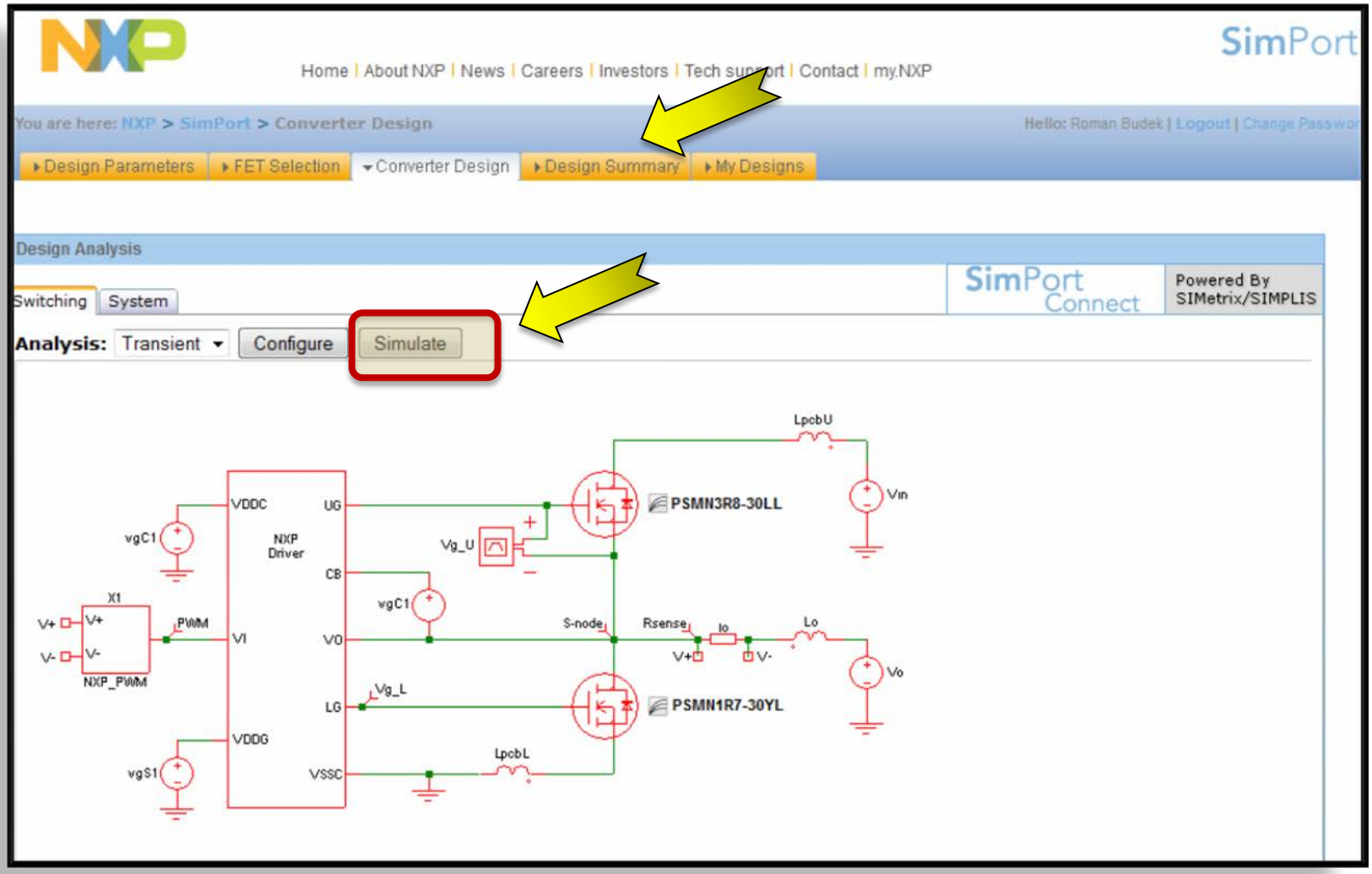
MOSFET Selection and Simulation Tool



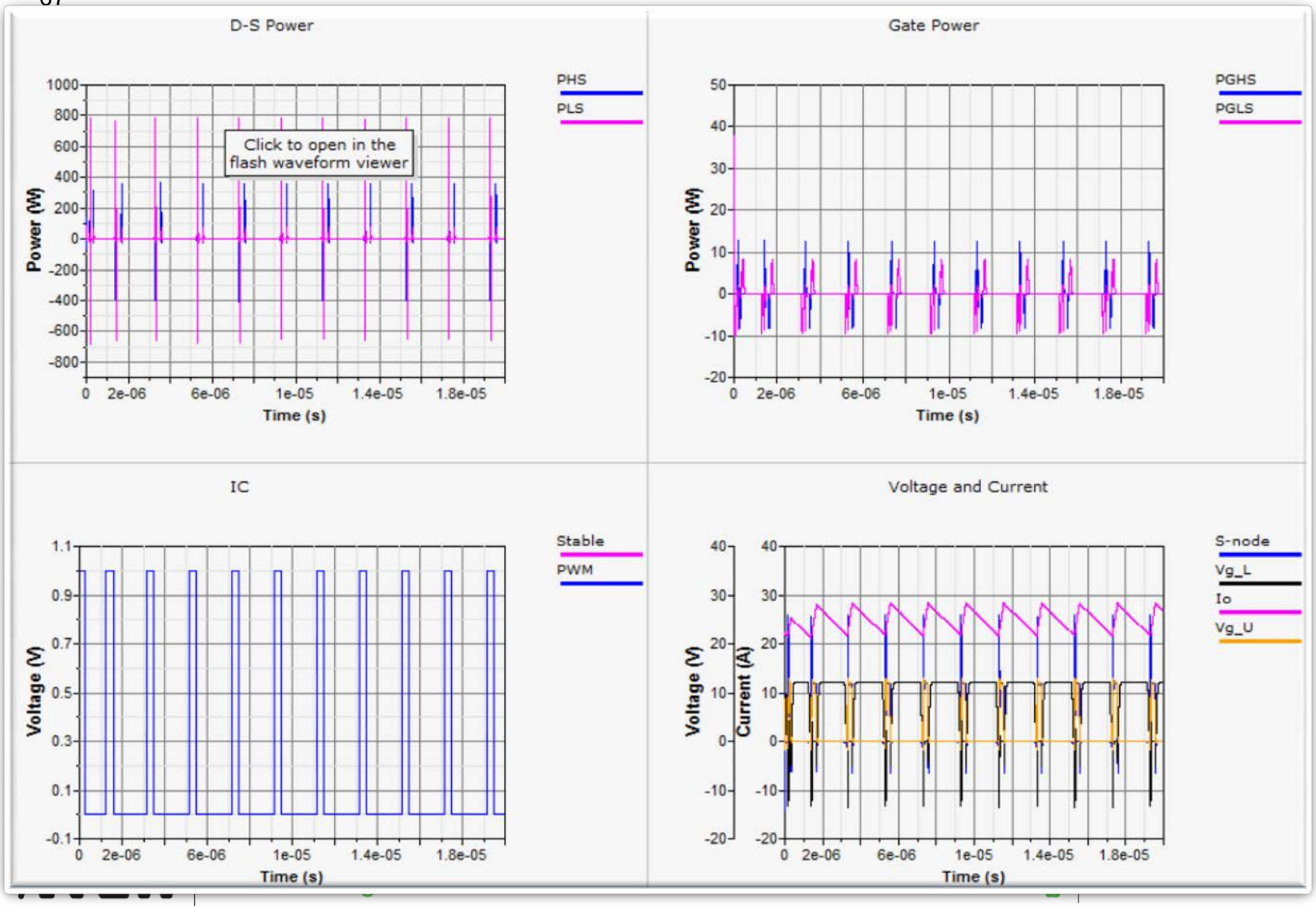
MOSFET Selection and Simulation Tool



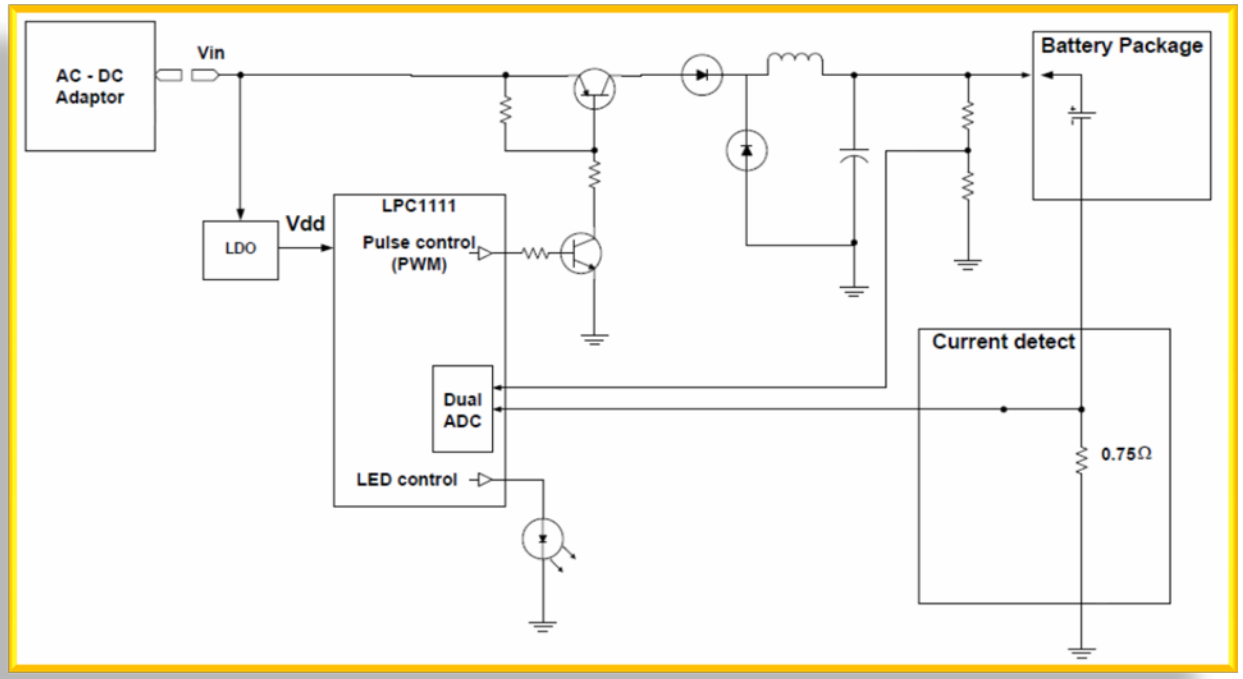
MOSFET Selection and Simulation Tool



MOSFET Selection and Simulation Tool

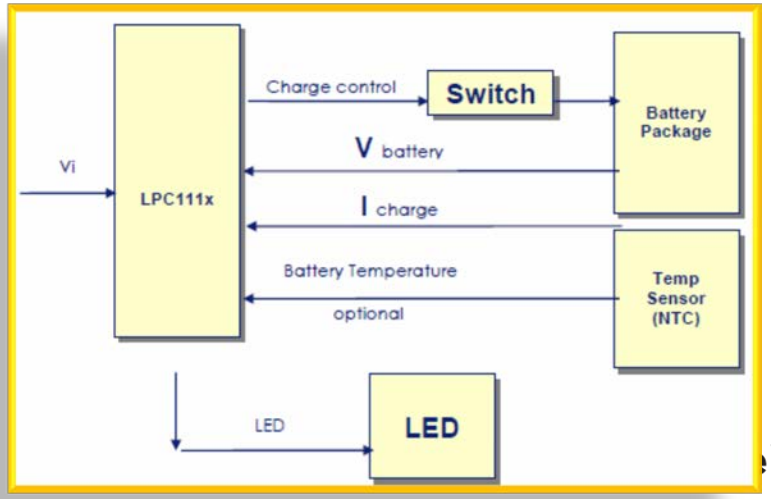


Battery Charger Application



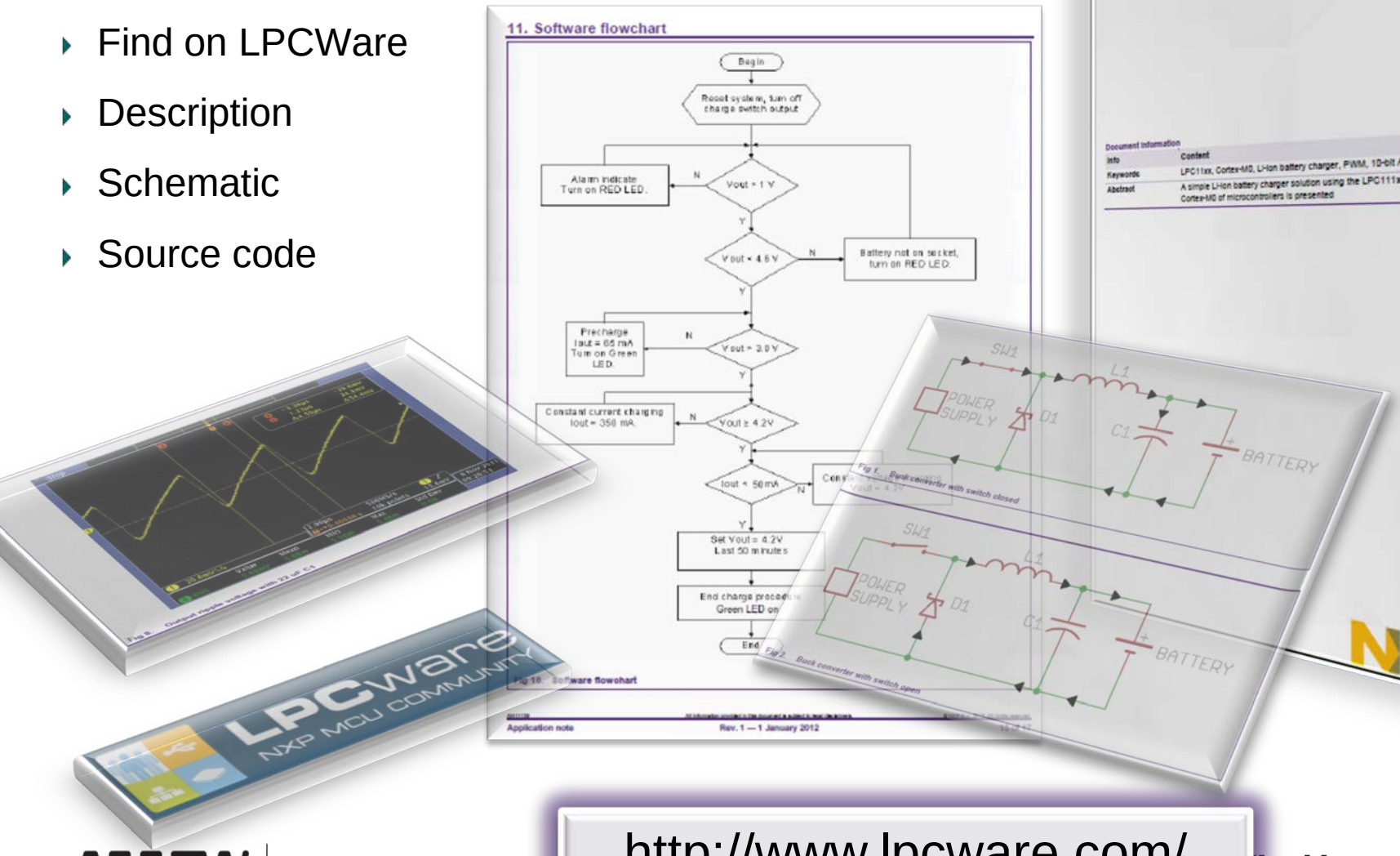
Requirements

- High Efficiency
- AC/DC Input
- DC/DC charging circuit
- Battery charging algorithm



Application Note 11139

- Find on LPCWare
- Description
- Schematic
- Source code



http://www.lpcware.com/

Strategic Advantages for DC/DC

- Highly efficient over wide load conditions
  - LDO have soft start to prevent over sizing components
  - Buck converter >90% efficiency from 2mA to 700mA loads
  - MEGA Shottky have low Vf
  - GreenChip designed for wide load conditions on flyback configurations with input voltages between 12V and 30V
  - BISS is 8x more efficient with lower VCEsat
  - NextPower has lower on resistance, improved switching, and best in class SOA and Id rating

Strategic Advantages for DC/DC (pg 2)

- Better reliability
  - Components run cooler when they are efficient
  - LDO limits in rush current
  - LDO has foldback to protect components
  - BISS has lower VCEsat which runs cooler
  - GreenChip have over power timer to protect device
  - NextPower has lower on resistance, improved switching, and best in class SOA and Id rating
  - LFPAK has no glue, no wires, no gold, and rated to 175ºC
- Higher power density
  - WLCP package for LDO and DC-DC
  - NextPower has lower on resistance and best in class SOA
  - Clip bond technology provides lower profile

How to move forward with DC/DC designs

- Look at LFPAK MOSFETs to increase reliability and decrease cost
- NXP LDO and regulators when high efficiency is required over wide load conditions
- NextPower MOSFETs when switching highly inductive loads like power tools and motors
- MOSFET cross reference and selection tools will help you convert and start new designs

Application Guide

AC/DC Conversion

- GreenChip
  - High eff at wide load range
  - Designs up to 500W
- Discretes
  - BISS
  - MEGA Shottky
- Power Diodes
  - NUR460P, BYC30X
  - 600V ultra low leakage
  - Reduces switching losses in MOSFET or IGBT

DC/DC Conversion

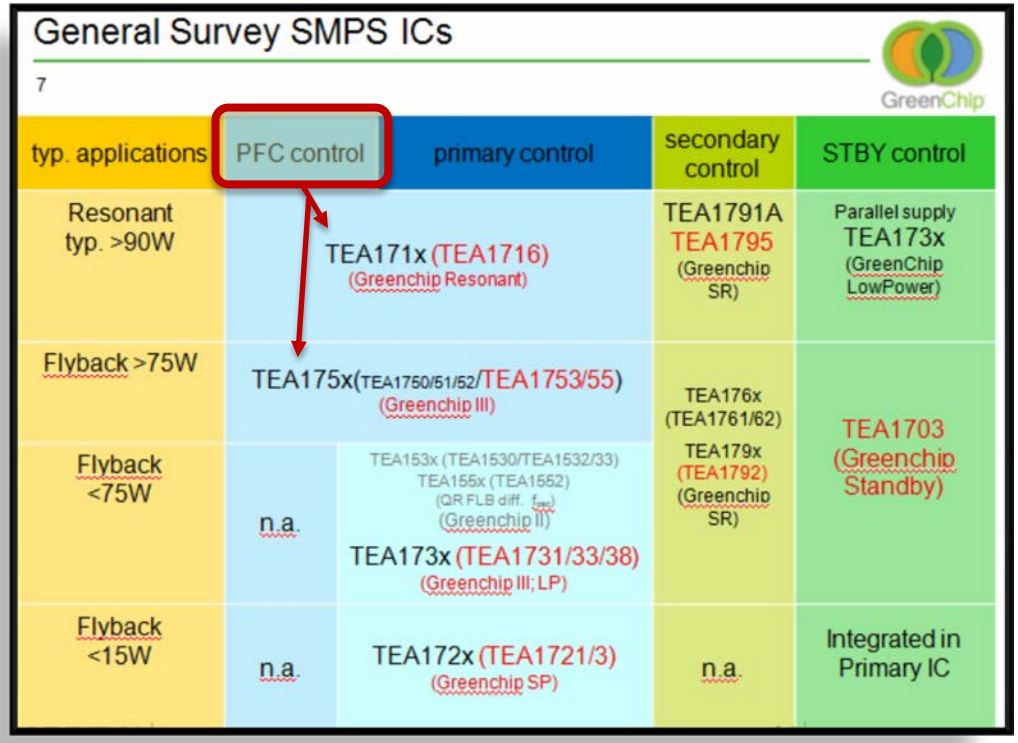
- LDO
  - LD68x***y***
  - Low in rush and soft start
- DC/DC
  - DCMx
  - High eff at wide load range
- GreenChip
- Discretes
  - BISS
  - MEGA Shottky
- Power MOS
  - PSMNx, BUFKx
  - Lowest RDSon / High Switching
  - LFPAK56, LFPAK33
  - Best in class current and avalanche

Switches and External Devices

- PFC
  - BYCx, BYVx, BYRx, BYWx
  - Optimized for PFC
- MOSFETs
- Load switches
- ORing MOSFETs

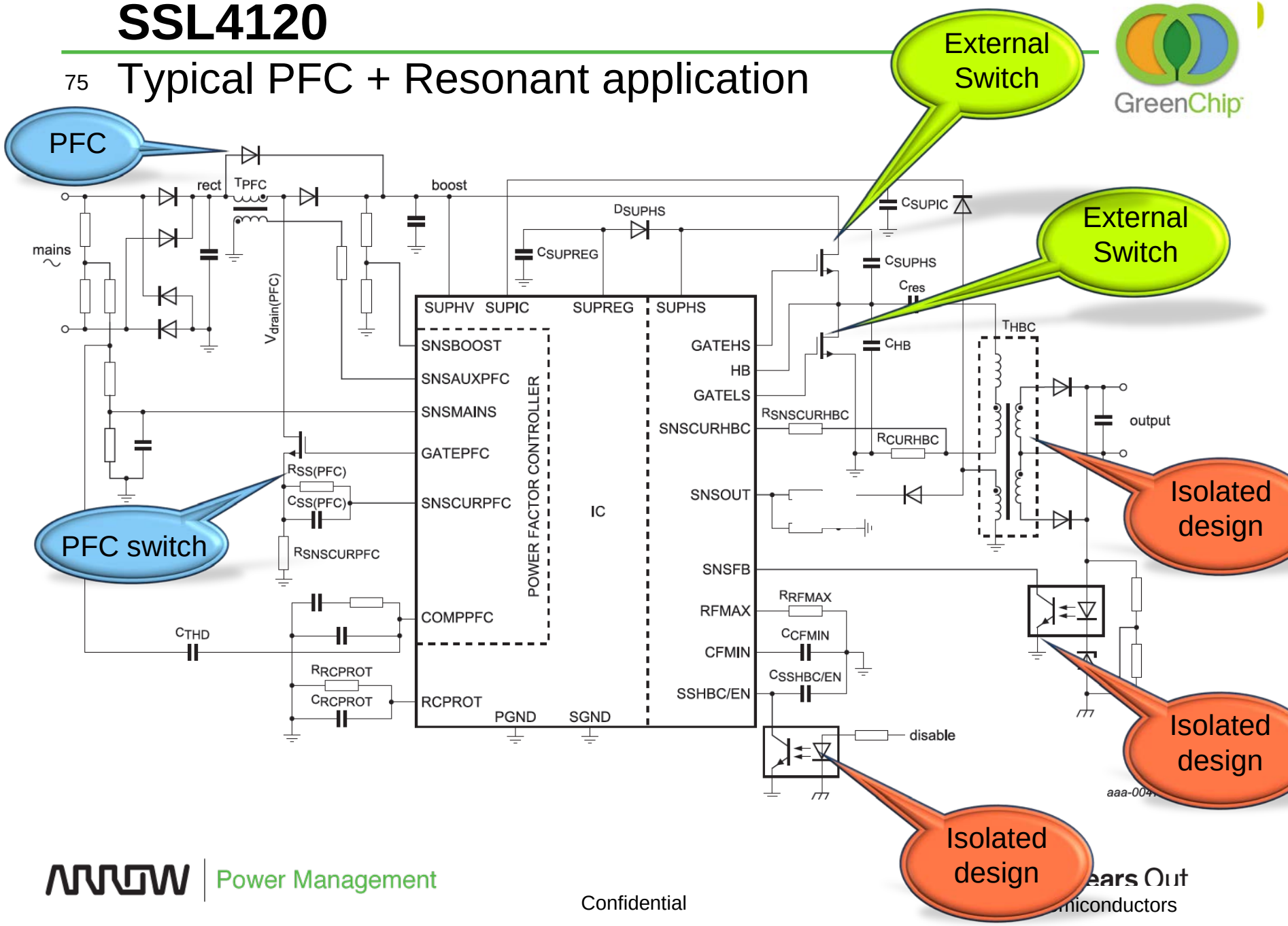
Power Factor Correction

- Not required for low wattage designs
- PFC control is included in many of the GreenChip devices
- Still requires external MOSFET



SSL4120

Typical PFC + Resonant application



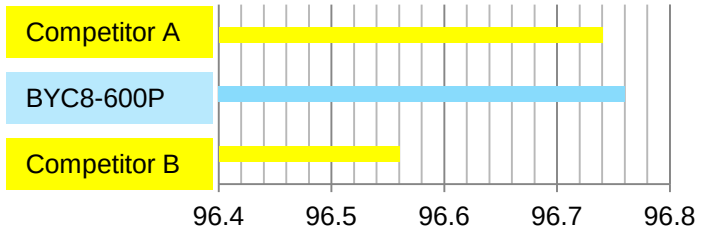
NXP Power diodes: BYC8(X)-600P *new release*

76

Product overview

- Voltage: 600V
- Current: 8A
- BYC hyper fast type for CCM mode PFC
- Package: TO-220, TO220FP
- Pb &Halogen free

Benchmark (efficiency)



Key features and benefits

- Low V_F and fast switching
- Soft recovery minimises oscillation
- Ultra low leakage current by platinum doped technology
- T_j = 175°C

Product Specification

PDF Product Specification
Download datasheet
BYC8X-600P

PDF Product Specification
Download datasheet
BYC8-600P

Key applications

- Printer power
- PDP TV power
- SMPS for PC and servers
- Switching adaptors
- LCD TV & Monitor power

Cross reference

ST: STTH8S06D
Fairchild: FFPF08S60S

Load Switches

The ultimate power saving device

Select the Active Devices based on specific application running. If the device is not needed, turn off its power!

Low cost, distributed Load Switches allow highly granular control of power to every device in the system

Ex: NX3P190

- 1.1-3.6V supply voltage
- 95mohms ON resistance
- Maximum switch current: 500mA
- Low ground current = 2 µA (Active)
- Power off leakage current = 2 µA (Standby)

Tradeoff power consumption with cost and component count

- *Note: if a device already has a standby mode LESS than 2 µA consider grouping several together on one load switch*

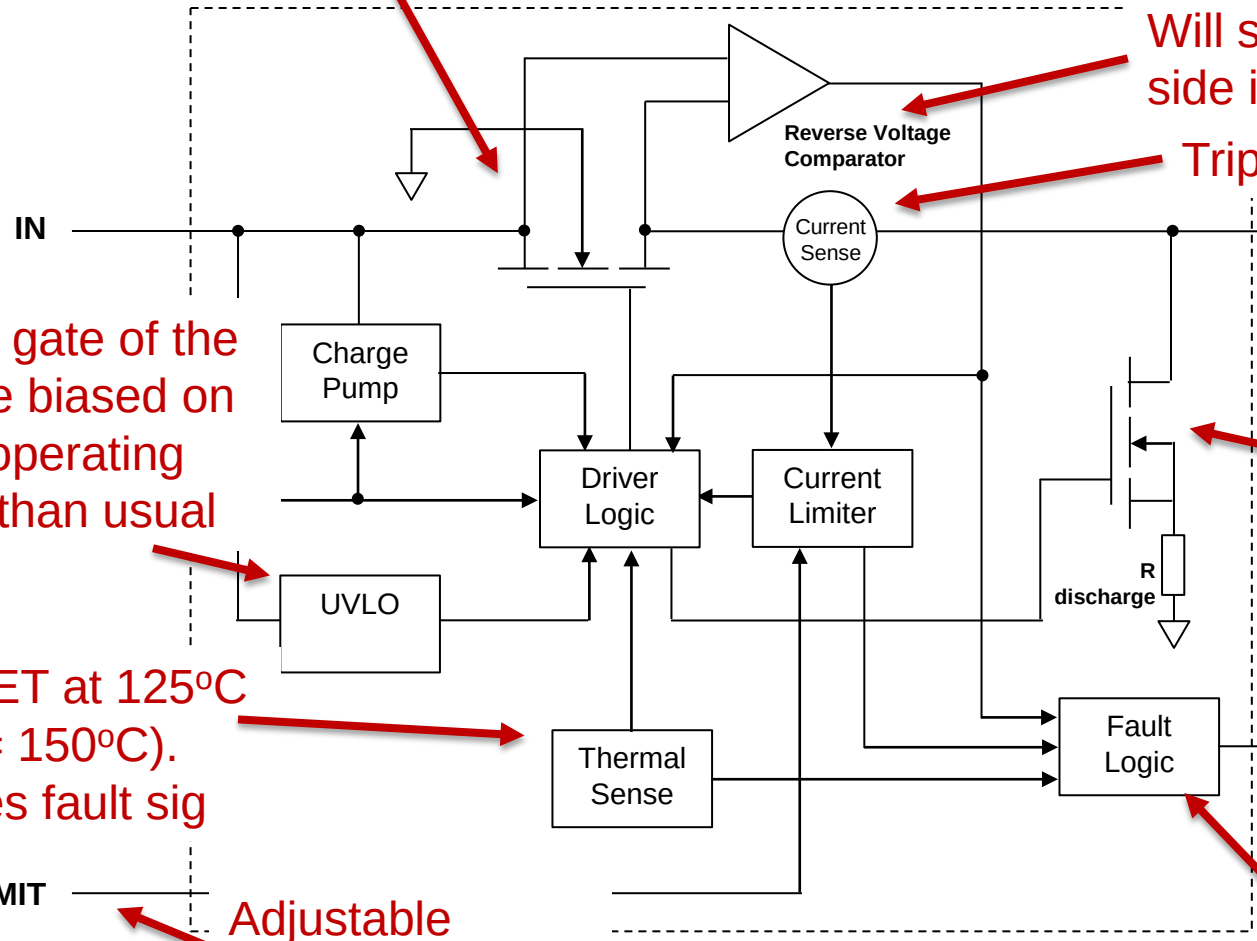
Load Switches

More Than Just a FET!

Operating Voltage: up to 6.5V

Drive Current: up to 3A

FET: 6.5V (20V in dev) at 3A



Will save FET if input side is UV

Trip current limiter

Allow the gate of the FET to be biased on at lower operating voltages than usual

Bleed off large C load for predictable MCU connections

Opens FET at 125°C (FET Tj = 150°C). Generates fault sig

Wait period before resetting device. Logic level indicator

Adjustable current limit

Load Switches

Feature Examples

Product Overview

Part	Input voltage (V)	Ron @1.8 V (mW)	Feature	Max Current (A)	Enable Pin	Package (mm)	Target Applications
NX3P190UK	1.1 to 3.6	95	Slew rate	0.5	Active high	WSCP4 0.8X0.8,0.4p	Mobile, computing
NX3P191UK	1.1 to 3.6	95	SR, Load discharge	0.5	Active high	WSCP4 0.8X0.8,0.4p	Mobile, computing
NX5P198UK	2.0 to 5.5	28	SR, Reverse polarity	3.0	Active high	WCSP6 1.0X1.5,0.5p	Mobile, computing
NX5P1039	1.8 to 5.5	20	Slew Rate	3.0	Active high	WCSP6 0.8x1.2,0.4p 1.0X1.5, 0.5p	Mobile, computing
NX3P2553	2.5 to 6.5	85	Constant current limit, UVLO, temp SD	3.0	Active high	QFN:6 2.0x2.0 PG: 3.0x3.0	TV / LCD, computing

High Efficiency Power Management

Standard PowerMOS – NextPower Live

Product family insights !

Package	30 V for 12 V supplies used in computing applications	100 V for 48 V supplies used in telecommunications
D²PAK (SOT404)	PSMN1R5-30BLE	PSMN4R8-100BSE
	PSMN3R4-30BLE	PSMN7R6-100BSE
LFPAK56 (Power-SO8)	PSMN2R0-30YLE	PSMN013-100YSE

www.nxp.com/nextpower-live

Only NextPower Live MOSFETs offer reliable linear mode performance AND low $R_{DS(on)}$ efficiency

- Electronic fuse
- Hot swap
- Load switch
- Soft start

NextPower Live MOSFETs

81 *Linear mode performance and low RDS(on)*

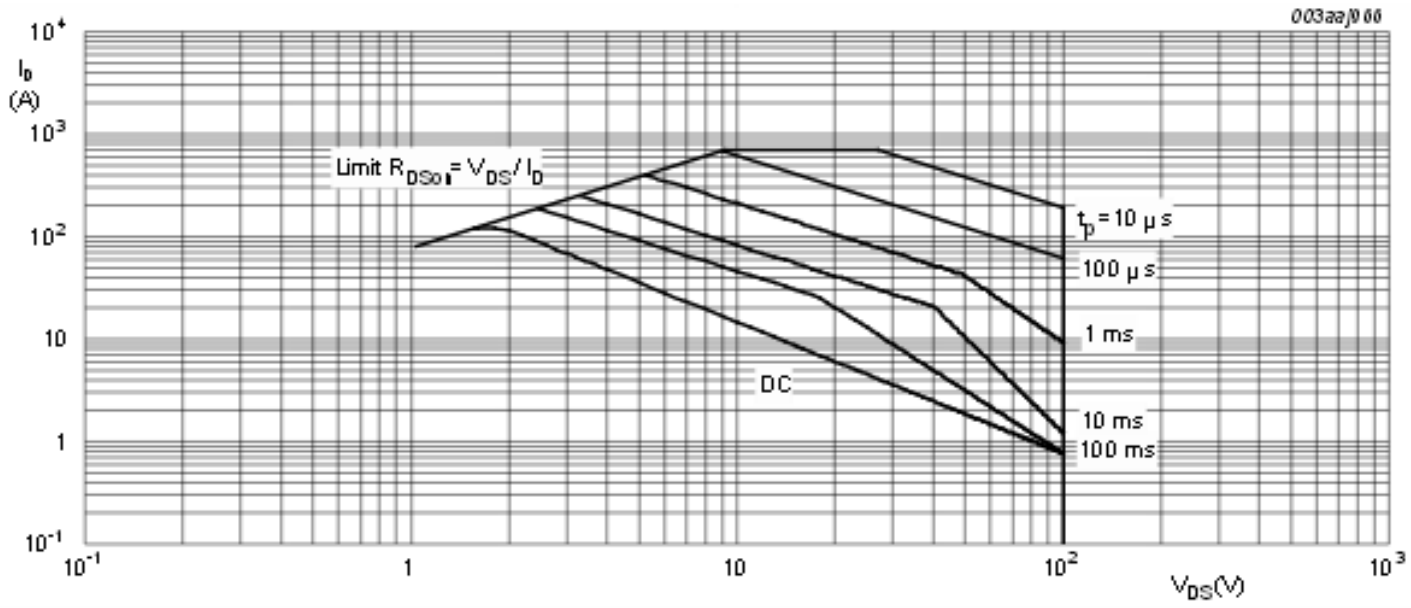
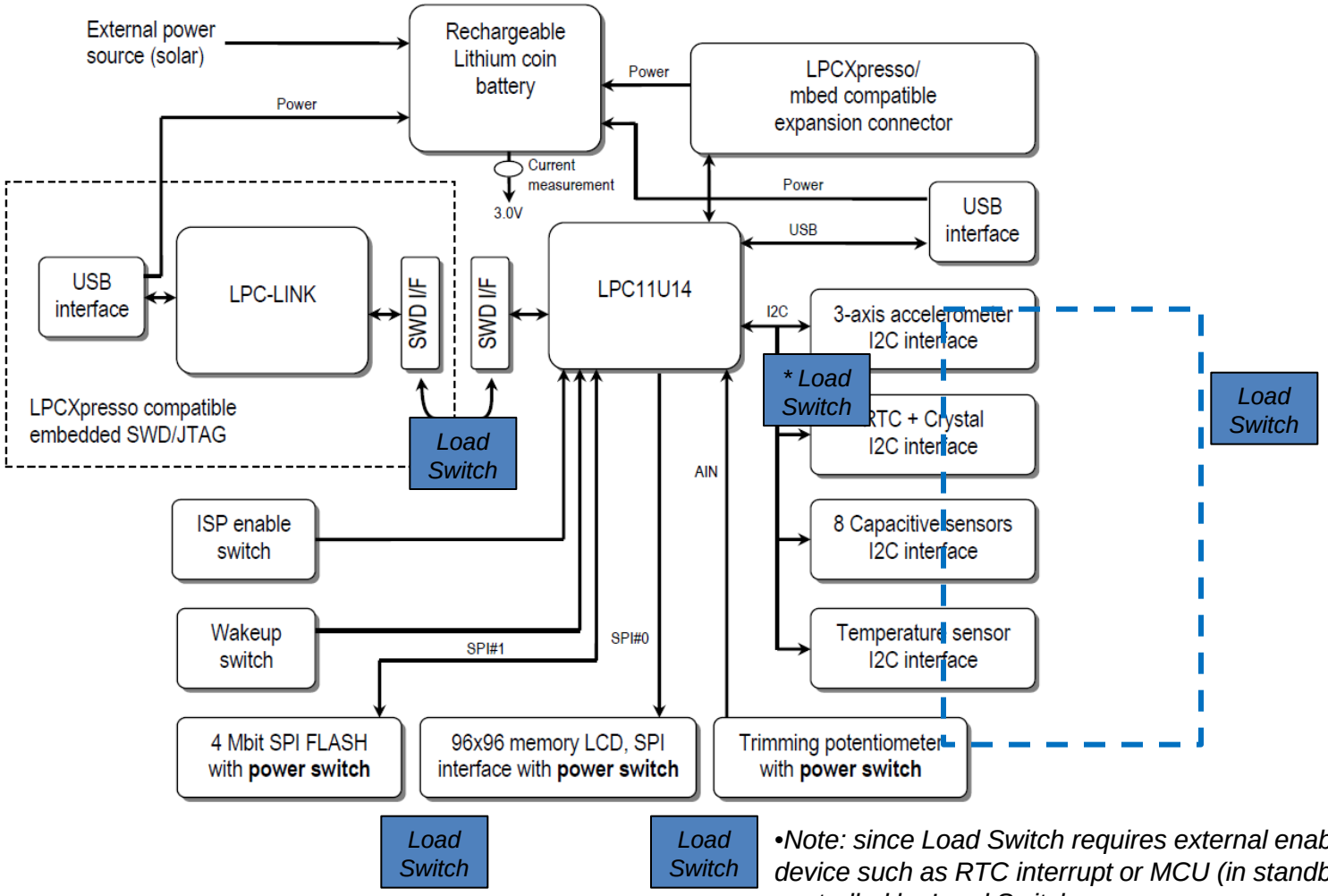


Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

$T_{mb} = 25$ °C; I_{DM} is a single pulse; Capped at 120 A due to package

Design Example for Load Switches

Going for ultimate power savings

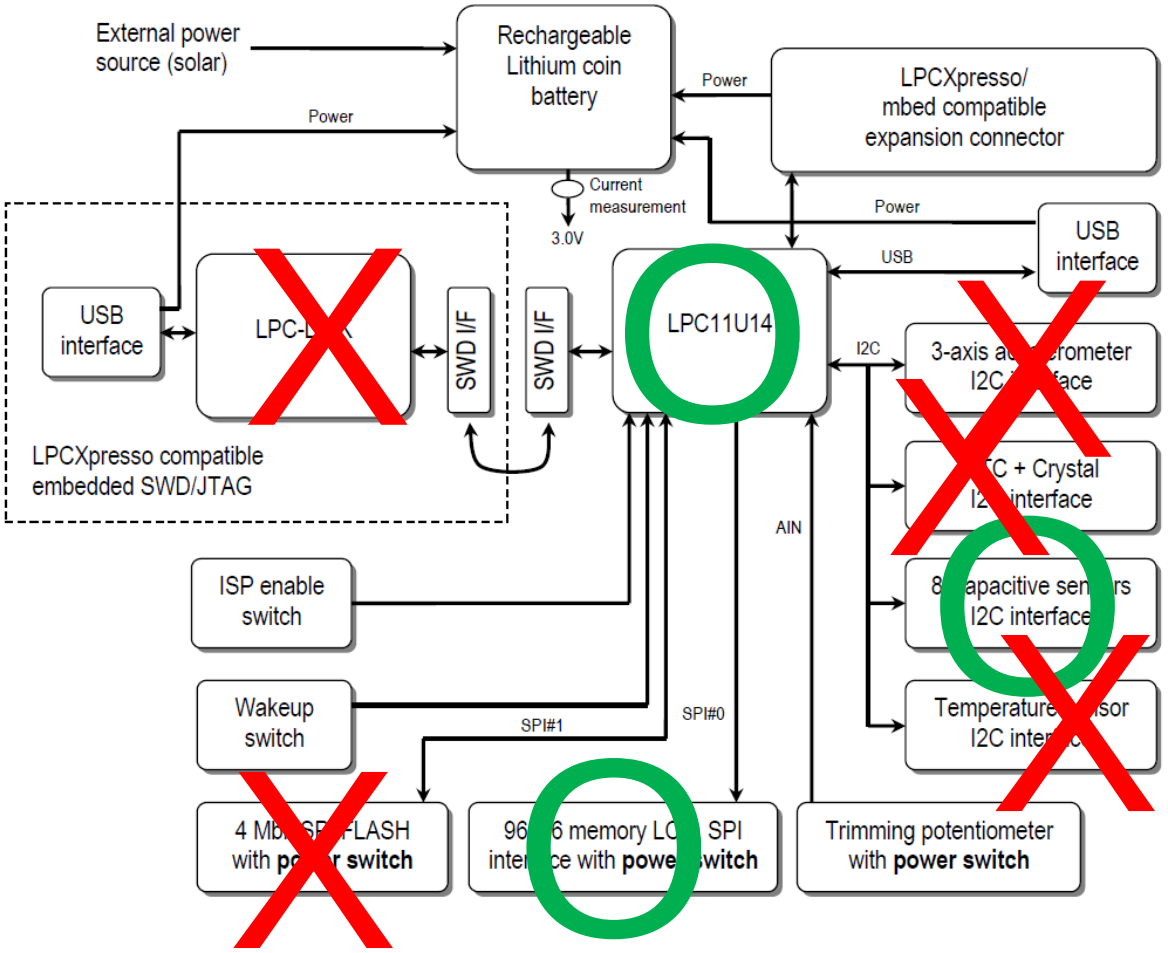


- *Note: since Load Switch requires external enable control one device such as RTC interrupt or MCU (in standby mode) will not be controlled by Load Switch*
- *Group several low power devices together on single Load Switch*

Example: "rotating globe" (with Load Switch)

- Devices needed
- Devices not needed

Device	Power Saved (uA)
LPC-Link	2
Accelerometer	0.1
Temp Sensor	0.2
RTC	0.15
FLASH	1.5
Load Switch	- 2
Total	**1.95**

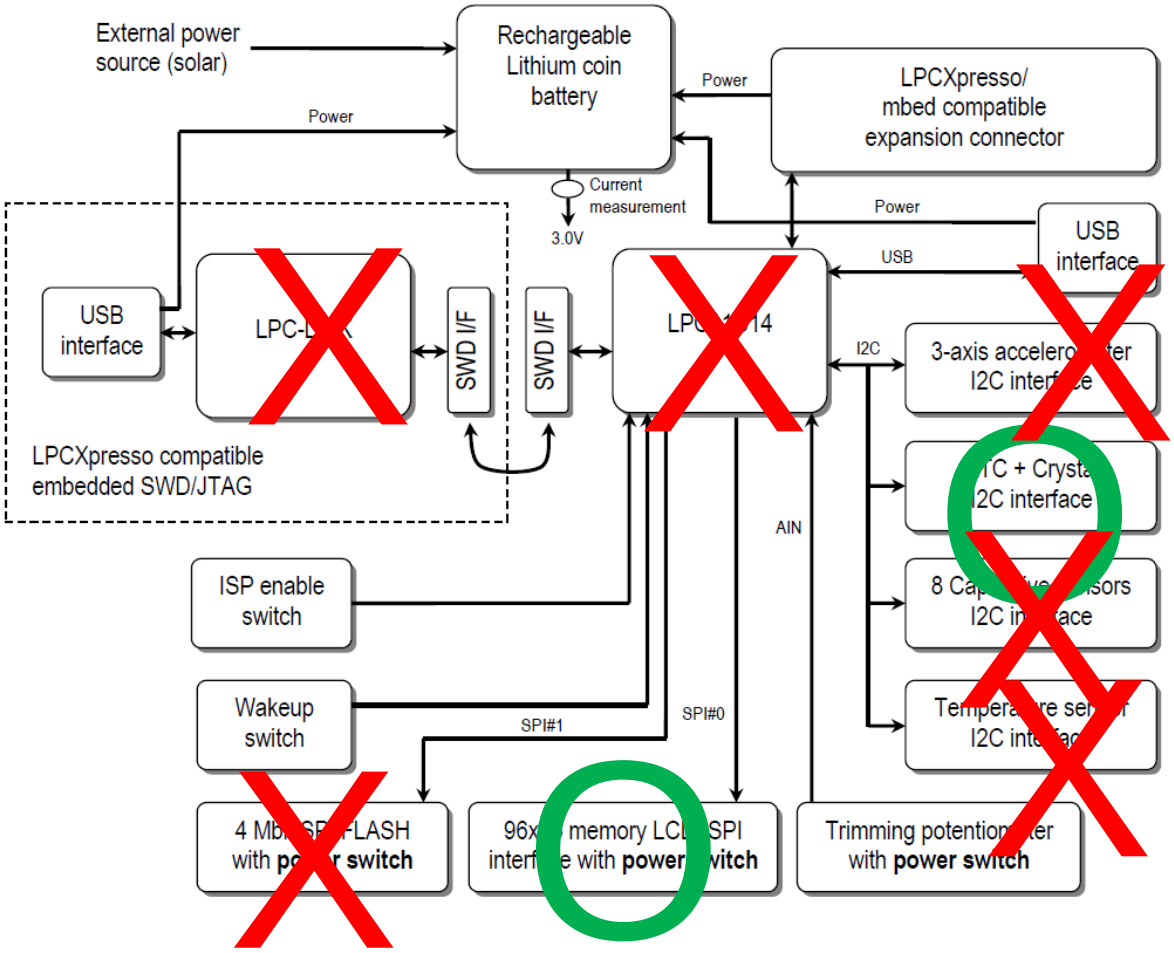


Extra life expected from Battery → x.x **hours** ***Little savings due to CPU intensive app***

Example: Real Time Clock (with Load Switch)

- Devices needed
- Devices not needed

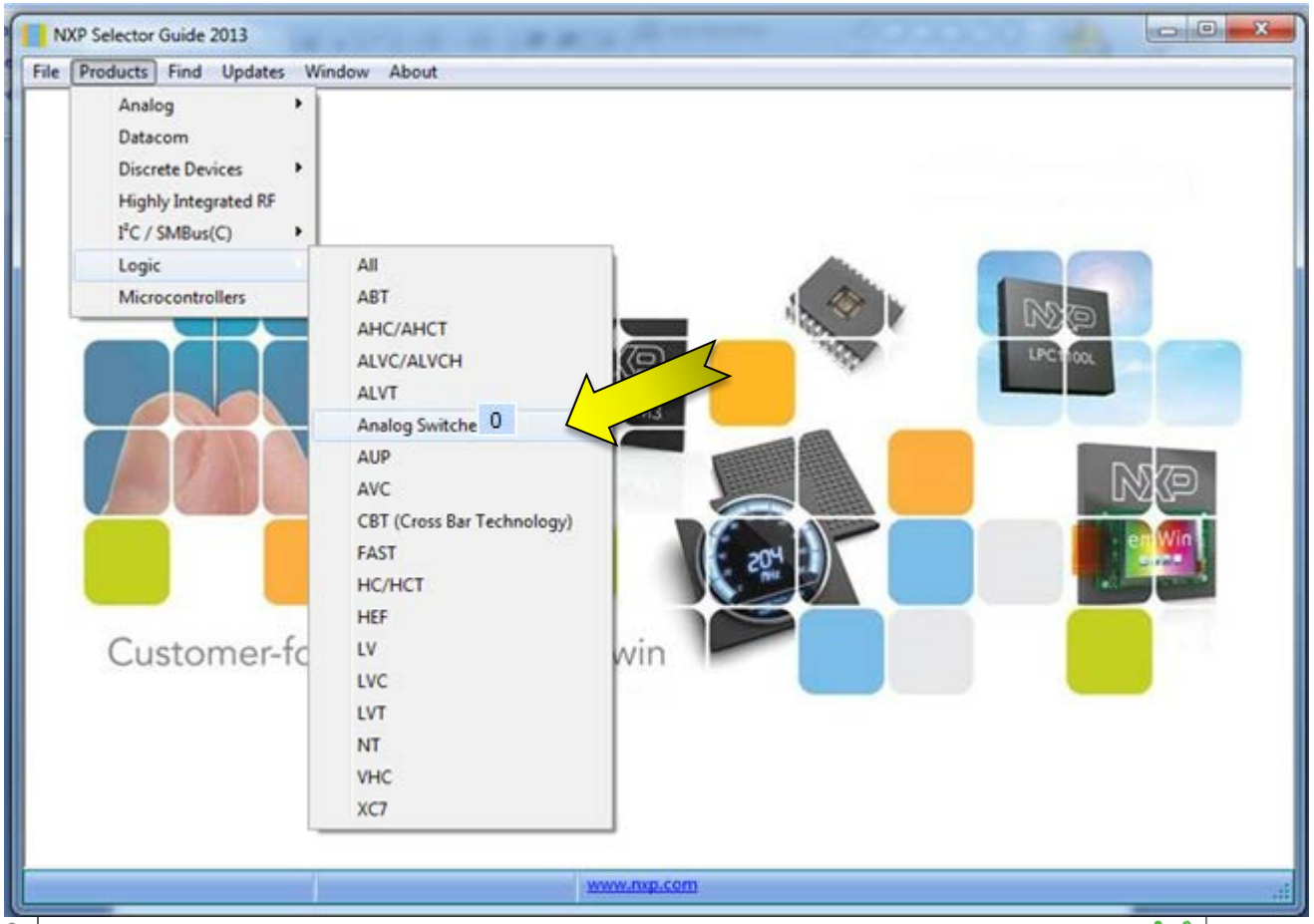
•Only the RTC has power: all other devices disabled via single load switch
•RTC interrupt connects to load switch EN
•At power up, MCU updates display then powers down



Extra life expected from Battery → x.x **days runtime**

Offline Cross Reference Design Tool

- Run the tool
- Follow the menus



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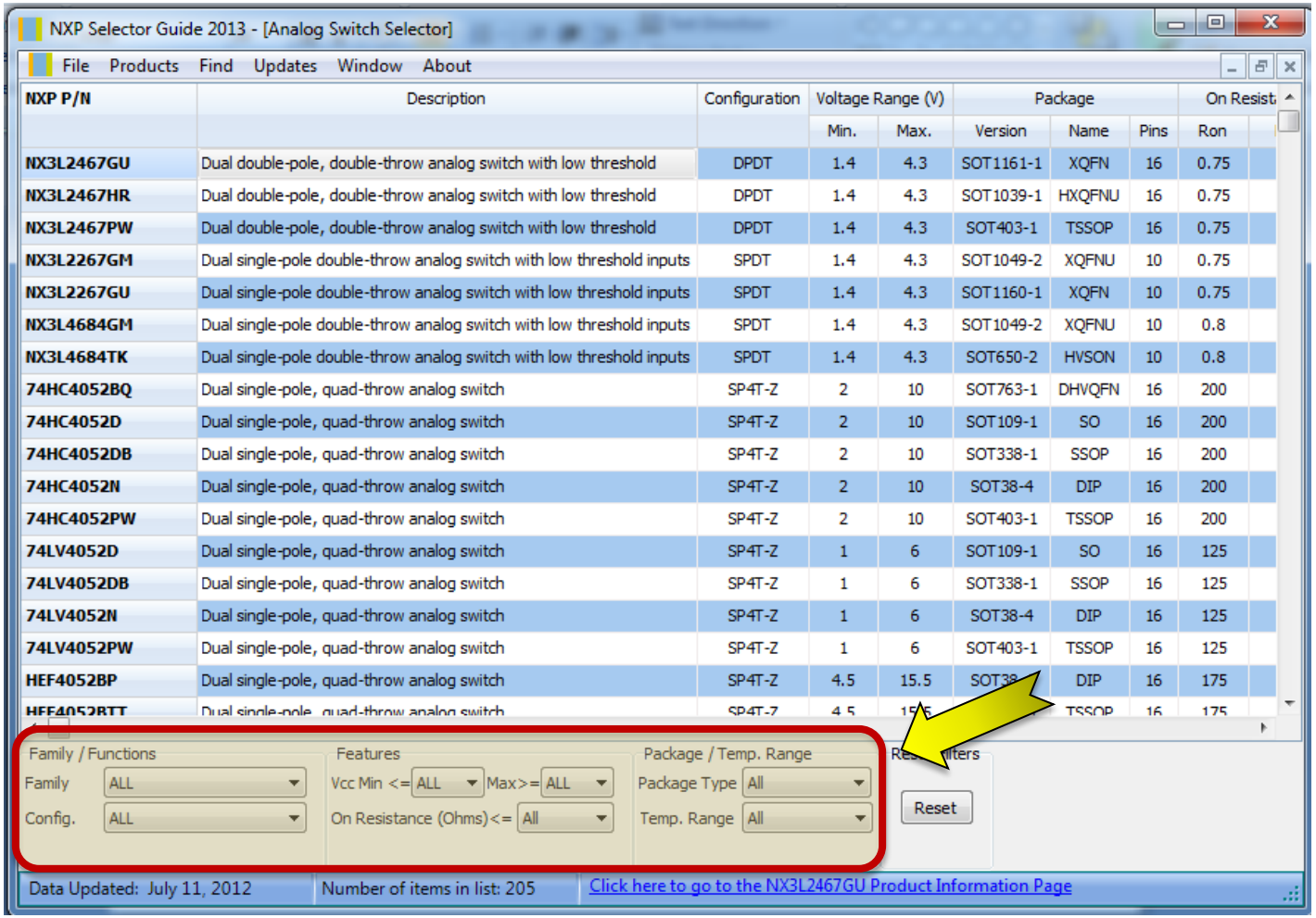

Strategic Advantages for External Devices

- Highly efficient
  - Hyper fast recovery diodes are best in class for PFC circuit
  - Extremely low leakage through a load switch
  - NextPower MOSFETs have low RDSon and good linear performance for ORing and Hot Swap applications

Strategic Advantages for Ext Devices (pg 2)

- Better reliability
  - Load switches operate up to 125ºC
  - Load switches contain safety shutdown circuits and alarms
  - Load switch has bleeder resistor for repeatable connectivity to a microcontroller
  - NextPower MOSFETs designed for linear operation
- Higher power density
  - Load switches combine many functions into a single device
  - NextPower low RDS(on) permits smaller heatsink

How to take advantage of external devices

- Consider load switches for designs which need low power consumption and high efficiency
- Use NextPower MOSFETs for hot swap applications
- Hyper fast recover diodes are best for use in PFC circuits

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  - MEGA Shottky
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Switches and External Devices

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  - Optimized for PFC
- MOSFETs
- Load switches
- ORing MOSFETs

Please contact us for any questions

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  New Customers: 800 833 3557
  www.arrownac.com/powermanagement